U.S. Army Center for Health Promotion and Preventive Medicine

USACHPPM REPORT NO. 12MA0896-08

INFLUENCE OF IRON SUPPLEMENTATION ON INJURY RISK IN BASIC COMBAT TRAINING

U.S. Army Center for Health Promotion and Preventive Medicine
Aberdeen Proving Ground, MD

US Army Research Institute of Environmental Medicine
Natick, MA

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13. SUPPLEMENTARY NOTES

14. ABSTRACT In a double-blinded study design, female Army basic trainees were randomized into either an iron supplement group (ISG, n=105) or a placebo group (PG, n=103). The ISG consumed 16 mg elemental iron daily. Prior to treatment, measures of physical activity, tobacco use, menstrual status, physical characteristics, body composition, physical fitness, and demographics were obtained. Blood was collected to identify subjects who were iron deficient (ID) or had iron deficiency anemia (IDA). Injury outcomes were obtained from outpatient medical surveillance data. Risk ratios (RR) and 95% confidence intervals (95%CI) were calculated. Cox regression indicated little difference in injury risk between the ISG and PG in multivariate analysis that included significant injury covariates (RR (ISG/PG)=1.14, 95%CI=0.79–1.64, p=0.48). For ID subjects (n=34), univariate Cox regression showed little difference in injury risk between the ISG and PG (RR (ISG/PG)=0.85, 95%CI=0.41–2.10, p=0.85). For IDA subjects (n=43), Cox regression also showed little difference in injury risk between the ISG and PG in multivariate analysis that included significant injury covariates (RR (ISG/PG)=0.87, 95%CI=0.36–2.07, p=0.75). Statistical power analysis indicated that sample sizes of 1,130 ID subjects and 1,680 IDA subjects (in each group) would be needed before these group differences (ISG vs. PG) were statistically significant at the p=0.05 level (power=80%). This study did not support the hypothesis that iron supplementation reduces injuries in BCT.

15. SUBJECT TERMS: iron deficiency, iron deficiency anemia, physical fitness, physical activity, demographics, cigarette, smokeless tobacco, age, body composition, menstrual status, race, component, marital status

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DEPARTMENT OF THE ARMY
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EXECUTIVE SUMMARY
USACHPPM REPORT NO. 12MA0896-08
INFLUENCE OF IRON SUPPLEMENTATION ON INJURY RISK IN BASIC COMBAT TRAINING

1. PURPOSE

a. Data from the National Health and Nutrition Examination Survey (NHANES) indicated that there is a high prevalence of iron deficiency in American women. This high iron deficiency prevalence is reflected among women entering Basic Combat Training (BCT) and the proportion of iron-deficient (ID) women has been shown to more than double over the course of BCT. Previous studies have shown that iron deficiency reduces endurance performance while iron supplementation improves iron status and endurance capacity among ID women involved in physical activity. Increasing aerobic endurance is known to reduce injury risk during BCT. Therefore, it was possible that iron supplementation could reduce injury rates in BCT, mediated through effects on improved aerobic endurance. The major purpose of the present study was to determine the effect of iron supplementation on injury risk among female recruits in BCT.

b. This was a double-blinded study. Women attending BCT at Ft Jackson, South Carolina, were randomized into two groups receiving either a daily iron supplement capsule (100 mg ferrous sulfate with 16 mg elemental iron) or a daily placebo capsule. There were 105 women in the iron supplement group (ISG) and 103 women in the placebo group (PG). Prior to randomization, volunteers filled out a questionnaire that asked them about their physical activity, tobacco use, and menstrual status before BCT. Each subject's height, weight, and body composition (skinfolds) were measured directly measured. Blood was collected by antecubital venipuncture to determine which women were ID or had iron deficiency anemia (IDA). Iron deficiency was defined as has having two or more of the following: serum ferritin <12.0 ng/ml, transferrin saturation <16.0%, or red cell distribution width >15.0%. IDA was defined as ID plus hemoglobin <12.0 g/dl.

c. The BCT companies administered a maximum of four Army Physical Fitness Tests (APFT) and scores were obtained from the BCT units. The Defense Medical Surveillance System (DMSS) provided demographic data on each subject. Attrition from training was obtained from a local data system maintained at Fort Jackson and cross-checked with the Resident Individual Training Management (RITM) system and the Automated Instructional Management System-Personal Computer (AIMS-PC). Attrition was defined as not completing BCT in the originally assigned BCT company within the 9-week period.

d. Injury outcomes were obtained from outpatient medical surveillance data compiled from the DMSS. The DMSS provided the dates of visits to the clinic and diagnostic codes using the

International Classification of Diseases, Revision 9 (ICD-9) for each visit within the 9-week BCT timeframe. Standard injury indices were calculated and person-time injury rates were compared between the PG and ISG. Univariate and multivariate Cox regression were used to compare group differences in time to first injury. Risk ratios (RR) and 95% confidence intervals (95%CI) were calculated.

2. CONCLUSIONS

a. Of the 207 women recruited for the study, 21 withdrew from the PG and 24 from the ISG (p=0.67). There were 11 women in the PG who attrited and 17 in the ISG (p=0.24). Person-time injury incidence rates (comprehensive injury index) were 10.8 and 11.6 injuries/1000 person-days in the PG and ISG, respectively (RR (ISG/PG)=1.08, 95%CI=0.76–1.52, p=0.34). Cox regression showed little difference in injury risk between the PG and ISG in univariate analysis (RR (ISG/PG)=1.10, 95%CI=0.76–1.56, p=0.59) or in multivariate analysis, which included significant injury covariates (RR (ISG/PG)=1.14, 95%CI=0.79–1.64, p=0.48).

b. There were 16 ID subjects in the PG and 18 ID subjects in the ISG. Person-time injury incidence rates were 13.4 and 11.7 injuries/1000 person-days in the PG and ISG, respectively (RR (ISG/PG)=0.87, 95%CI=0.39–1.97, p=0.37). Univariate Cox regression showed little difference in injury risk between the PG and ISG (RR (ISG/PG)=0.85, 95%CI=0.41–2.10, p=0.85)

c. There were 22 IDA subjects in the PG and 21 IDA subjects in the ISG. Person-time injury incidence rates (comprehensive injury index) were 11.2 and 10.4 injuries/1000 person-days in the PG and ISG, respectively (RR (ISG/PG)=0.93, 95%CI=0.42–2.02, p=0.42). Cox regression showed little difference in injury risk between the PG and ISG in univariate analysis (RR (ISG/PG)=0.88, 95%CI=0.40–1.94, p=0.76) or in multivariate analysis, which included significant injury covariates (RR (ISG/PG)=0.87, 95%CI=0.36–2.07, p=0.75).

d. It had been hypothesized that iron supplementation might increase aerobic endurance during training and this could possibly mediate a reduction in injuries, since increasing aerobic endurance has been shown to reduce injury incidence. However, the present study found that iron supplementation had little influence on injury rates during BCT even when other significant injury covariates were considered. When subjects with ID or IDA at the start of the investigation were examined separately, injury rates during BCT were similar regardless of whether or not the subjects received the iron supplement.

e. There were suggestions from the data that iron supplementation improved aerobic endurance to a greater extent than the placebo. This could not be demonstrated statistically because of the small number of subjects for whom 2-mile run times were obtained. Nonetheless, some trends could be noted indicating larger improvements in the ISG compared with the PG as shown in Figures 1, 2, and 3. In Figure 3, showing the IDA subjects, results were somewhat confounded because of the greater initial performance of the ISG. However, previous studies have shown that those with slower initial 2-mile run times in BCT can improve those times to a greater extent than those with faster initial times, presumably because those with faster times are closer to their maximal training potential. In this case, the ISG began with a faster time than the PG, and maintained and expanded this initial lead over the PG by the end of training.

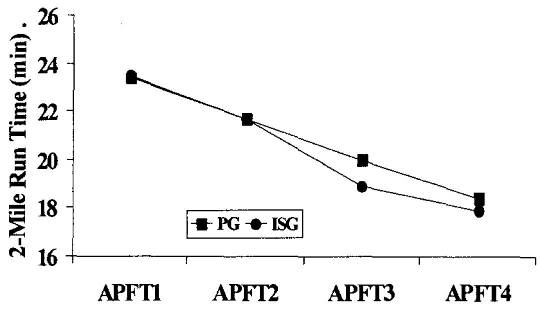

Figure 1. Changes in APFT 2-Mile Run Scores in PG and ISG (Entire Group)

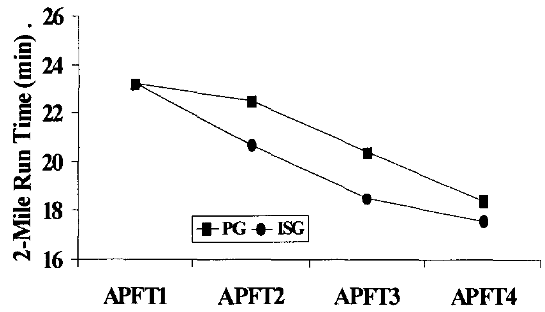

Figure 2. Changes in APFT 2-Mile Run Scores in PG and ISG with ID

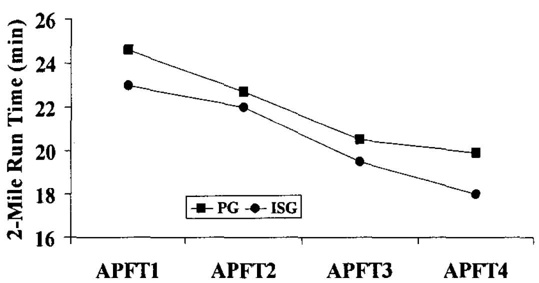

Figure 3. Changes in APFT 2-Mile Run Scores in PG and ISG with IDA

f. Thus, there is some weak evidence that aerobic endurance did improve more with iron supplementation than with the placebo, but this improvement may not have been great enough to mediate a reduction in injury risk. On the other hand, with a larger sample size, the observed differences would have been statistically significant. For the ID subjects statistical power analysis indicated that with a sample size of about 1,130 in each group, the observed difference would be statistically significant (hazard ratio (ISG/PG)=0.85, hazard rate=0.1025/week, $p<0.05$, power=80%). For the IDA subjects, statistical power analysis indicated that with a sample size of about 1,680 in each group, the observed difference would be statistically significant (hazard ratio (ISG/PG)=0.88, hazard rate=0.0921/week, $p<0.05$, power=80%).

3. RECOMMENDATIONS. The present study does not support the hypothesis that iron supplementation reduces injuries in BCT.

CONTENTS

Tables

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INFLUENCE OF IRON SUPPLEMENTATION ON INJURY RISK IN BASIC COMBAT TRAINING

1. REFERENCES. Appendix A contains the scientific/technical references used in this report.

2. AUTHORITY. This was a cooperative investigation conducted with the United States Army Research Institute of Environmental Medicine (USARIEM). In February 2007, USARIEM requested assistance from the US Army Center for Health Promotion and Preventive Medicine because of USACHPPM's extensive experience with injuries in Basic Combat Training. The project was considered research and a research protocol was prepared by the investigators and submitted to the USARIEM Human Use Review Committee. The project was approved in July 2007. The approval letter is in Appendix B.

3. PURPOSE

a. Data from the National Health and Nutrition Examination Survey (NHANES) indicated there is a high prevalence of iron deficiency (ID) in a broad sample of American women (1), which is reflected among women entering Basic Combat Training (BCT) (2). Interestingly, the situation appears to be exacerbated during BCT: the prevalence of ID has been shown to increase 2.4-fold near the end or shortly after BCT (2). ID has been shown to reduce endurance performance (3), while iron supplementation has been shown to improve iron status and endurance capacity among ID women involved in physical activity (4, 5). Low levels of aerobic endurance are associated with higher injury rates in BCT (6, 7) and improving endurance capacity in BCT has been shown to reduce injury incidence (8). Thus, improving the iron status of iron deficient women in BCT may improve their endurance capacity and possibly mediate a reduction in injury risk.

b. The major purpose of the present study was to determine the effect of iron supplementation on injury risk among female recruits in BCT. This was part of a larger study examining the effects of iron supplementation on iron status, physical performance, body composition, menstrual status, and injuries among women in BCT (9). Data from this project may result in modifications to garrison feeding programs and a variety of Defense Department rations, as well as improved nutritional education for female Soldiers.

4. BACKGROUND LITERATURE

a. Iron is the fourth most abundant terrestrial element, making up about 5% of the Earth's crust. The total iron content in the human body is 3–5 gm. About two-thirds of total body iron is

bound in hemoglobin, myoglobin, and some mitochondrial enzymes, while the rest is stored in bone marrow, liver, and spleen tissue. Men have about 1000 mg of storage iron, while women have about 300 mg.

b. Iron is a nutritionally essential trace element involved in a wide variety of metabolic functions. Iron-containing proteins are critical for oxygen transport, oxygen diffusion, and energy production to fuel physical activity. Hemoglobin in red blood cells circulates oxygen from the lungs to the rest of the body. Myoglobin facilitates diffusion of oxygen into muscle mitochondria. Mitochondrial dehydrogenase enzymes are involved in the oxidation of acetyl-CoA to produce NADH and $FADH_2$. Cytochromes participate in the electron transport chain and are involved in ATP production (3, 10, 11).

a. <u>Iron Deficiency and Iron Deficiency Anemia</u>

(1) Despite the metabolic importance of iron, iron deficiency is one of the most common nutritional deficiency disorders in the world (11, 12). Low iron status has been characterized in three stages. In stage 1, low serum ferritin indicates depleted iron stores, but iron-dependent protein production is still normal. It should be noted that ferritin is primarily an indicator of hepatic iron stores and does not reflect the myoglobin, iron-dependent enzymes, or respiratory proteins. In stage 2, the supply of iron to the bone marrow is inadequate and there is reduced production of iron-dependent proteins, resulting in low serum ferritin, decreased transferrin saturation, and a rise in free erythrocyte protoporphyrin levels. Serum transferrin binds over 95% of serum iron and a saturation of <16% is inadequate to meet basal erythropoietic needs. Protoporphyrin binds iron to form hemoglobin so that an increase in unbound protoporphyrin indicates less iron availability. In stage 3, all the characteristics of stage 2 are present, plus hemoglobin levels are low, thus reducing oxygen-carrying capability (13–16). More recently, it has been shown that the concentration of soluble serum transferrin receptor is a sensitive indicator of iron status. Transferrin receptor is a protein present on membranes of many cell types and is regulated (expressed) by cellular iron such that as cellular iron decreases, transferrin receptor levels increase (16).

(2) In NHANES, individuals were categorized as iron deficient (ID) if they presented with at least two of the following three indicators: serum ferritin <12 ng/mL, transferrin saturation <15%, or erythrocyte protoporphyrin >1.24 µmol/L. Individuals were classified as having iron deficiency anemia (IDA) if they were ID and had hemoglobin levels below 12 g/dL (1, 17). Another study used similar indicators, but instead of erythrocyte protoporphyrin they used a red cell distribution width of >15% as one of the ID indicators (2).

(3) The 1988–1994 NHANES survey (also called NHANES III) found that among women 16–49 years old the prevalence of ID and IDA was 11% and 5%, respectively (1). Subsequently, NHANES 1999–2000 found that among women aged 16–49 the prevalence of ID was 13% and among those 20–49 IDA prevalence was 4%. Prevalence was higher in certain ethnic groups. Among Black and Hispanic women, the prevalence of ID was 19% and 22%, respectively (17). In athletes, the prevalence of ID appeared to be even higher than in the general population, but estimates vary widely, depending, at least in part, on the sport and how ID is defined. In general, it is estimated that 25% to 35% of female athletes may be ID (16).

b. ID and IDA in Military Training

(1) Among female Israeli conscripts just entering basic training, the prevalence of ID and IDA was 16% and 10%, respectively (18). A recent survey of women entering BCT in the US Army found that the prevalence of ID and IDA was 13% and 6%, respectively (2), similar to the most recent NHANES findings (17). Interestingly, near the conclusion of BCT or in early Advanced Individual Training (AIT), the overall incidence of ID and IDA was 33% and 21%, respectively. There were ethnic differences as shown in Table 1 (19). This increase in prevalence after training is not restricted to US Army BCT. Among Israeli women involved in a 7-week basic training course, reductions in serum iron (32%) and reductions in serum ferritin (60%) were seen after 2 weeks of training, and these measures remained lower than baseline values for the duration of training. Changes in hemoglobin and hematocrit were more transitory, decreasing after 2 days of training, then returning to near baseline values at 2 weeks, and remaining near baseline for the remainder of training (20).

Table 1. Prevalence of Iron Deficiency and Iron Deficiency Anemia by Race in Early BCT and Either Later BCT or Early AIT (data from Reference 19)

Race	Iron Deficiency (%)		Iron Deficiency Anemia (%)	
	Early BCT	Late BCT or Early AIT	Early BCT	Late BCT or Early AIT
Caucasian	9	25	2	11
Hispanic	7	44	0	22
African American	17	33	8	23

(2) The decline in iron status during BCT may be attributed to low dietary iron intake and/or increased physical activity. Surveys of nutritional intake in military women generally show inadequate intake of iron in both field ration studies and studies in dining halls (21). Women in BCT are highly physically active, walking an average of almost 16,000 steps per day covering an estimated daily distance of about 11 km (22). In addition, about 4 days each week they perform 1–1.5 hours of more intense physical training designed to improve their physical fitness (23–25).

(3) Studies have demonstrated that heavy physical activity is associated with reductions in serum iron, serum ferritin, and hemoglobin levels (20, 26, 27). Several mechanisms have been proposed to account for this. There appears to be an expansion of plasma volume during aerobic training that can result in a hemodilution and pseudoanemia (14, 28, 29), although one study ruled out hemodilution as a mechanism (27). In studies involving ^{59}Fe-labeling, distance runners' gastrointestinal (fecal, urine) iron losses were 0.8 mg/day when not training, 1.5 mg/day after racing, and 3.1 mg/day after intense training (30, 31). Iron may be lost in sweat at a rate of 300–530 μg/liter sweat; thus a sweat loss of 1L/hr for 6 hours might result in an hypothetical iron loss of 3 mg (14). However, sensitive ^{59}Fe labeling studies showed little or no appearance of the ^{59}Fe label in sweat (30). Menstruation can lead to an iron loss of 0.5 mg/day when blood losses are 30 ml, but with heavy bleeding (>60 ml) or longer periods (>5 days) losses can be greater. There may be potential losses from hemolysis due to mechanical stress of exercise, direct trauma to the bladder or kidney, exercise-induced muscle damage, or dehydration. However, these latter factors may be of consequence only in extreme cases when exercise intensity is high and there

are so many hemolyzed cells that the amount of free hemoglobin overwhelms the hepatic recovery system (14, 29, 32).

c. Iron Deficiency, Iron Deficiency Anemia, and Performance

(1) Haas and Brownlie (3) systematically reviewed the literature on the influence of ID and IDA on aerobic capacity (VO_2max), endurance performance (time to sustain a fixed activity intensity), activity efficiency (energy output/activity performed), and voluntary activity. Both human and animal studies strongly indicated that IDA is causally related to decreased aerobic capacity and that the severity of the anemia is directly proportional to the degree of impairment. ID alone did not appear to impair aerobic capacity. In animal studies, ID and IDA both impaired endurance performance, but at the time of the review, human studies on endurance performance were few and inconclusive. One of the major problems with human studies was that most used exercise intensities >80%VO_2max or progressive treadmill tests to exhaustion. These exercise intensities are likely to heavily involve non–iron-dependent oxidative and anaerobic pathways for ATP production. Tests of lower exercise intensities involving longer times to exhaustion would more appropriately tax aerobic energy sources in which iron-dependent myoglobin, mitochondrial enzymes, and cytochromes would be involved. The few studies on activity efficiency and voluntary activity strongly suggested that both ID and IDA result in impairment.

(2) Rat studies have shown that mitochondrial enzyme activity and respiratory chain proteins concentrations decrease in IDA (33–36), but human studies employing subjects with ID or IDA are less conclusive (37, 38). Reinfusing erythrocytes into rats with IDA to restore hemoglobin levels resulted in improvements in VO_2max, suggesting that IDA affects oxygen-carrying capability (erythrocytes to muscle). However, reinfusing erythrocytes into IDA rats resulted in no improvement in exercise time to exhaustion, suggesting that mitochondrial and respiratory proteins were still effected by the ID (33).

(3) One human study examined the effects of reinfusing erythrocytes. Celsing et al. (37) induced IDA by repeated venesection and a low iron diet in nine men (reducing serum ferritin from 60 to 7 μg/l and hemoglobin from 146 to 110 g/l). Erythrocytes were reinfused to restore hemoglobin (to 145 g/l). In the control (before anemia), anemic, and reinfused states, cycle ergometer VO_2max was 4.6, 3.7, and 4.5 l/min, respectively. In the control, anemic, and reinfused states, cycle ergometer time to exhaustion at 70%VO_2max was 49, 26, and 52 minutes, respectively. Cytochrome c oxidase activity was similar in the control, anemic, and reinfused states. Thus, restoration of hemoglobin returned both VO_2max and endurance times to control conditions and did not influence activity of an iron-containing protein.

d. Iron Supplementation Studies

(1) Rat studies have shown that iron supplementation improved endurance capacity and decreased lactate production (35). Physical training by rats with IDA improved the activity of mitochondrial enzymes and the concentration of cytochrome c (34), but did not improve their VO_2max (39). Findings from human studies are more complex and because of their importance to the major hypothesis of this study, these studies are reviewed individually and chronologically below.

(2) Schoene et al. (40) gave ID female athletes (serum ferritin <28 ng/ml) 300 mg of ferrous sulfate or a placebo for 2 weeks. After 2 weeks, the placebo group was given the iron supplement and continued with it for an additional 2 weeks. Before treatment, at 2 weeks, and at 4 weeks after, athletes performed a progressive cycle ergometer VO_2max test to exhaustion. Iron supplementation improved iron status (ferritin increased from 10 to 22 ng/ml). VO_2max was not influenced by iron supplementation but there was a reduction in maximal blood lactate during the VO_2max test (10.3 to 8.4 mmol/l).

(3) Matter (41) gave ID female marathon runners (ferritin <40ng/ml) daily dosages of 500 mg of amino acid chelate iron (50 mg elemental iron) or a placebo for 10 weeks. Before and after treatment, subjects performed an incremental treadmill VO_2max test to exhaustion. After treatment, iron status improved in the iron-supplemented group (ferritin increased from 30 to 60 ng/ml). VO_2max, maximal heart rate, and peak blood lactate did not change after treatment in either the iron-supplemented or placebo groups. It should be noted that this study used a much less strict criterion to identify ID subjects (ferritin <40 ug/l) than other studies.

(4) Rowland et al. (42) gave ID female high school cross country runners (ferritin <20ng/ml) daily dosages of 975 mg of ferrous sulfate or a placebo for 4 weeks. Before and after treatment, subjects performed an incremental treadmill VO_2max test to exhaustion. After treatment, iron status improved in the iron-supplemented group (ferritin increased from 8 to 25 ng/ml). VO_2max improved in the placebo group (49.4 to 52.6 ml/kg*min) but much less in the iron supplemented group (53.5 to 54.3 ml/kg*min). On the other hand, endurance time to exhaustion on the test improved post-treatment in the iron-supplemented group (17.0 to 17.6 minutes, every subject but one improved), but declined in the placebo group (17.1 to 16.4 minutes, every subject's performance declined).

(5) Newhouse et al. (38) gave ID female recreational runners (ferritin <20ng/ml) two daily dosages of 320 mg ferrous sulfate (100 gm elemental iron) or a placebo for 8 weeks. Before and after treatment they performed a Wingate power test, a treadmill anaerobic speed test, and a progressive treadmill VO_2max test to exhaustion. Serum ferritin levels improved in the iron-supplemented group (12 to 38 ng/dL). There were no post-treatment changes in power on the Wingate test. Performance on the anaerobic speed test showed small, nonsignificant changes for the iron-supplemented group (41 to 45 sec) and the placebo group (44 to 45 sec). VO_2max showed a small, nonsignificant improvement for the iron supplemented group (51.3 to 52.7 ml/kg*min), but no change for the placebo group (50.6 ml/kg*min both times).

(6) Klingshirn et al. (43) gave ID female runners (ferritin <20ng/ml) two daily dosages of 160 mg of ferrous sulfate (50 mg elemental iron) or a placebo for 8 weeks. Before and after treatment, subjects performed 1) an incremental treadmill VO_2max test to exhaustion, and 2) a treadmill endurance test at a speed 2–3% slower than the individual's most recent 10 km race pace. After treatment, iron status improved in the iron-supplemented group (ferritin increased from 12 to 23 ng/ml; total iron-binding capacity decreased from 318 to 275 μg/dl). VO_2max improved a nonsignificant 2% in the iron supplemented group (49.6 to 50.5 ml/kg*min) and 0.5% in the placebo group (51.5 to 51.7 ml/kg*min). Time to exhaustion on the treadmill endurance test improved 26% in the iron supplemented group (67 to 83 minutes), but also improved 22% in the placebo group (66 to 80 minutes). The groups differed little in blood lactate concentration or respiratory exchange ratio. The authors concluded that iron

supplementation in this study did not improve VO_2max and that the improvements in endurance time were due to a learning effect in both groups.

(7) LaManca and Haymes (5) gave ID female athletes (ferritin <20ng/ml), 90% of them runners, two daily dosages of 150 mg of ferrous sulfate (50 mg elemental iron) or a placebo for 8 weeks. Before and after treatment, subjects performed an incremental cycle ergometer test to exhaustion and a cycle endurance test involving exercise at 80% VO_2max to exhaustion. After treatment, the iron-supplemented group's iron status improved (ferritin increased from 11 to 23 ng/dl). On the incremental endurance test, there was a significant group × treatment time interaction, with the iron supplement group improving their VO_2max by 4% (40.2 to 41.7 ml/kg*min) and the placebo group decreasing theirs by 4% (41.2 to 39.5 ml/kg*min). There were no significant changes in maximal heart rate, ventilation, or respiratory exchange ratio. On the 80% VO_2max endurance test, total post-treatment exercise time increased by 38% (37 versus 51 minutes) in the iron-supplemented group, but there was no difference in the placebo group (46 min both times). Post-treatment, peak blood lactate also decreased in the iron-supplemented group (5.0 vs 3.9 mM/l), but not in the placebo group (3.7 mM/l both times).

(8) Zhu and Haas (44) gave untrained ID women daily dosages of 45 mg of elemental iron (as ferrous sulfate) or a placebo for 8 weeks. Before and after treatment, subjects performed a progressive cycle ergometer VO_2max test and a 15-km cycle time trial. The iron-supplemented group improved their iron status at the end of treatment (ferritin from 14 μg/l to 37 μg/l; transferrin receptor levels from 6.4 to 4.5 mg/l). The iron-supplemented group improved their VO_2max more than the placebo group (7% versus 2%), but there were no differences in time to complete the 15-km distance. The energy expenditure rate in the iron-supplemented group during the 15-km time trial was significantly less than in the placebo group (by 8.4 kcals/min).

(9) Brutsaert et al. (45) administered either a placebos or two daily doses of 10 mg of elemental iron (as ferrous sulfate) to ID women. The iron status of the iron-supplemented women improved after the 6-week treatment period (serum iron from 11 to 23 μmole/l; transferrin saturation from 20 to 40%). Women were compared before and after treatment on a dynamic knee extension test presumed to have a high rate of muscle-specific oxygen consumption. The decline due to fatigue was attenuated by about 27% in the iron-treated group.

(10) Hinton and Sinclair (46) gave ID women a daily dose of 30 mg of elemental iron (as ferrous sulfate) or a placebo for 6 weeks. Before and after the 6-week treatment, both groups performed a cycle ergometer VO_2max test and a 60-minute cycle ergometer exercise bout at 60% of the pre-test VO_2max. On the VO_2max test, the placebo group showed a decline in ventilatory threshold from pre- to post-treatment, but this did not occur in the iron-supplemented group. The ventilatory threshold is linked to the onset of blood lactate accumulation and acidosis; thus, a lower ventilatory threshold suggests that nonoxidative energy sources were used at a lower work rate (47), although there is some controversy on this point (48). The correlation between the change in log ferritin and the change in the ventilatory threshold in the iron-supplemented group was 0.49 ($p=0.03$). On the submaximal test, the iron-supplemented group demonstrated significantly greater efficiency (energy expended/work rate) than on the pre-test (7%), although some improvement in efficiency was also seen in the placebo group (4%).

(11) The above studies were performed largely with women who were already physically active and who apparently continued their activity while the iron treatments were ongoing (the exception was Brutsaert et al. (45)). One study, described below, examined women who were given iron supplements and then began a progressive exercise program. This study, and the two studies further analyzing data from it, is more relevant to the current discussion, since in BCT women will be undergoing a progressive physical training program.

(12) Hinton et al. (4) gave iron-depleted women a daily dose of 100 mg of ferrous sulfate (10 mg elemental iron) or a placebo for 6 weeks. After 2 weeks of treatment, the women began training on a cycle ergometer (25 minutes, 5 days/wk, 75% to 85% heart rate max) and continued training for 4 weeks. The iron status of the iron-supplemented group improved (serum ferritin from 10 to 15 μg/l; transferrin saturation from 19 to 32%) at the end of training. Compared with baseline, women in the iron supplementation group had greater improvements on a 15-km cycle ergometer time trial (5% vs 10%) and greater improvements in efficiency (7% vs 14%, energy expended/work rate). Improvements in VO_2max were associated with decreases in serum transferrin receptor status, suggesting that increased efficiency of oxygen utilization at the tissue level was associated with improved tissue iron status. Additional analyses of these data (49, 50) showed that subjects with the highest serum transferrin receptor levels at baseline had greater responses to iron supplementation. When iron-supplemented and placebo women with serum transferrin receptor levels >8.0 mg/l were compared, iron-supplemented women had much greater improvements in VO_2max and greater decreases in respiratory exchange ratios. During the 15-km cycle time trial, iron-supplemented women tended to have higher work rates. These data strongly suggested that ID without anemia but with elevated serum transferrin receptor levels impairs training adaptations. The data also support the idea that these impairments can be mitigated with iron supplementation.

(13) These studies provide some support for the concept that improving the iron status of ID subjects who are new to physical training can result in greater increases to VO_2max, higher work rates during time trials, and greater exercise efficiency (4, 49, 50). The data also indicate that, in the absence of training, iron supplementation in ID individuals can improve exercise efficiency (44, 46) and resistance to fatigue (45). Among ID athletes previously engaged in physical activity, iron supplementation appears to improve endurance capacity in most (5, 42, 43), but not all (44) studies. Based on ventilatory threshold, respiratory exchange ratio data, and blood lactate, there is some suggestion that these improvements are associated with improved oxidative capacity (4, 5, 40, 46, 49, 50).

e. <u>Injuries and Iron Supplementation</u>

(1) During BCT, 14% to 42% of men and 36% to 67% of women will experience one or more injuries (51). Numerous risk factors for injuries in BCT have been identified, including the amount of physical training, training company, older running shoes, the summer season, female gender, high foot arches, past ankle sprains, low muscular endurance, high and low extremes of flexibility, low levels of physical activity prior to BCT, menstrual dysfunction, cigarette smoking prior to BCT, older age, and low aerobic endurance. Multivariate analyses have consistently shown that cigarette smoking prior to BCT, low levels of aerobic fitness, menstrual dysfunction, and low levels of physical activity prior to BCT are independent injury risk factors (6, 51–53).

(2) Recruits with either slower 2-mile run times or lower VO_2max have been shown to have higher injury rates in BCT (7, 54, 55). ID can reduce training-related gains in endurance performance (3, 4, 49, 50). ID women receiving iron supplementation have greater training-related improvements in aerobic endurance than ID women who do not receive iron supplementation (4, 5). Increasing aerobic endurance (i.e., 2-mile run times) is known to reduce injury risk during BCT (8). Therefore, it is possible that iron supplementation could reduce injury rates in BCT, mediated through its effect on improving aerobic endurance.

5. METHODS.

a. Subjects. The subjects of this study were women from five BCT companies from one battalion at Fort Jackson, South Carolina. The BCT cycle for the battalion ran from 10 August to 12 October 2007. On the second or third day after arrival at BCT, they were briefed in small groups on the purposes and risks of the study and provided their informed consent to participate in the study. They signed an informed consent statement after asking questions in accordance with Army Regulation 70-25 involving the use of Soldiers as subjects of research (56). The study protocol was approved by the institutional review board of the USARIEM and the US Army Research and Development Command.

b. Study Design and Interventions. This was a double-blinded, placebo-controlled study. Subjects were randomized into two groups receiving either an iron supplement capsule or a placebo capsule. Capsules were prepared in compliance with FDA standards for the preparation of nutritional supplements under the supervision of a trained pharmacist. The capsules were provided to the subjects by the study team once each day in the early morning (about 0500 hours). The iron supplement group (ISG) received a yellow capsule containing 100 mg of ferrous sulfate with cellulose filler. The placebo group (PG) received an identical yellow capsule containing an equal volume of cellulose filler with no ferrous sulfate. The 100 mg of ferrous sulfate contained 16 mg of elemental iron. This dose was chosen based upon evidence documenting its effectiveness in improving biochemical indicators of iron status in a relatively short period of time (6 weeks or less) and its ability to affect physical performance (4, 49, 50). The supplement was administered daily rather than weekly, because of the documented efficacy of this dosage frequency to improve iron status (57). Furthermore, this dose was chosen because of the lack of side effects reported in similar trials (4, 49, 50) and because such doses appear not to inhibit the absorption of other minerals, including zinc (58). The investigators and volunteers were blinded as to the assignment of volunteers to the treatment groups and a third party held the group identification code. After completion of the BCT cycle, the code was provided to the investigators for analysis.

c. Initial Testing (Questionnaire, Physical Characteristics, Body Composition)

(1) Prior to receiving the iron or placebo treatment, volunteers filled out a questionnaire (shown in Appendix C) about their physical activity, tobacco use, and menstrual cycle prior to BCT. This questionnaire was part of the larger study mentioned earlier (9). Questionnaire items of interest selected for the current study were those relating to physical activity, smoking, and menstrual status, since these have been shown to be injury risk factors in prior studies (25, 51, 52).

(2) Height and weight measurements were made with volunteers dressed in their physical training uniforms (shorts and short-sleeved shirt) without shoes. Vertical height was measured to the nearest 0.1 cm using a SECA 214 Stadiometer (Baltimore, MD). Volunteers stood on a flat surface in their stocking feet, feet together, knees straight, and the head, shoulder blades, buttocks, and heels in contact with the stadiometer pole. Body weight was measured to the nearest 0.1 kg using a calibrated TotalComp T500E digital scale (Fairlawn, NJ).

(3) Skinfold measurements were used to determine body fat. Lange calipers were used to measure skinfold thickness at the triceps, suprailiac, and abdominal sites, according to standardized procedures. The three skinfolds, along with age and race, were used to derive body fat according to the equations of Jackson and Pollock (59). Fat free mass was calculated using the following equation: weight – ([%body fat*0.01]*weight).

d. Blood Sample Collection and Analysis

(1) Blood was collected by antecubital venipuncture during the initial testing. Hemoglobin and red cell distribution width were determined immediately after blood collection, using fresh blood and an ONYX hematology analyzer (Beckman Coulter, Fullerton, CA). Red cell width distribution measures the amount red blood cells vary in size, calculated as follows: (standard deviation of red cell width ÷ mean cell width) × 100. Serum ferritin was determined by microparticle enzyme immunoassay (IMx, Abbott Laboratories, Abbott Park, IL). Serum iron and total iron binding capacity were determined with a Beckman Coulter Synchron CX7 (Beckman Coulter, Fullerton, CA). Transferrin saturation was determined by dividing serum iron by total iron binding capacity.

(2) ID was defined as has having two or more of the following: serum ferritin <12.0 ng/ml, transferring saturation <16.0%, red cell width distribution >15.0%. IDA was defined as ID plus hemoglobin <12.0 g/dl.

e. Demographic Data. The Defense Medical Surveillance System (DMSS) provided demographic data on each subject. These data were downloaded from the Defense Manpower Data Center (DMDC). Information on each subject included component (regular Army, Army reserve, National Guard), educational level, marital status, and race.

f. Army Physical Fitness Test Data

(1) Army Physical Fitness Test (APFT) scores were obtained from the basic training companies. Subjects took their first APFT within 1 to 4 days of entering their training companies. Subsequent tests were taken at about 2-week intervals, although not all training companies administered all tests. There were a maximum of 4 APFTs and these are referred to hereafter as APFT1 through APFT4.

(2) The APFT consisted of three events, a 2-minute maximal effort push-up event, a 2-minute maximal effort sit-up event, and a 2-mile run for time. One company performed a 1-mile run (rather than the 2-mile run) for their first APFT, but the other events were the same. The three fitness test events were administered by drill sergeants using well standardized procedures (60). For the push-up, the subject lowered her body in a generally straight line to a

point where her upper arm was parallel to the ground, and then returned to the starting point with elbows fully extended. For the sit-up, the subject's knees were bent at a 90° angle, fingers were interlocked behind the head, and a second person held the ankles, keeping the heels firmly on the ground. The subject raised her upper body to a vertical position so that the base of the neck was anterior to the base of the spine and then returned to the starting position. Scores were the number of push-ups and sit-ups that were successfully completed within the separate 2-minute time periods. The performance measure for the run was the time taken to complete the 2-mile (or 1-mile) distance. Time between events was no less than 10 minutes (60).

g. Injury Data. Injury outcomes were obtained from outpatient medical surveillance data contained in the Standard Ambulatory Data Record (SADR), as compiled from the Defense Medical Surveillance System (DMSS). The DMSS provided the dates of the visits to the clinic and the diagnostic codes using the International Classification of Diseases, Version 9 (ICD-9) for each visit within the 9-week BCT timeframe. Six injury indices were calculated: the Installation Injury Index (III), the Modified Installation Injury Index (MIII), the Training-Related Injury Index (TRII), the Overuse Injury Index (OII), and the Comprehensive Injury Index (CII). All indices include specific ICD-9 codes, as described previously (Knapik et al., 2004). The III and TRII were developed by personnel at the DMSS. The III has been used to compare injury rates among military posts and is reported on a monthly basis at the Army Medical Surveillance Activity (AMSA) website (http://amsa.army.mil). The TRII is limited to lower extremity overuse injuries and has been used to compare injury rates among basic training posts; it is reported on a monthly basis to the Army Training and Doctrine Command (TRADOC) surgeon. The MIII, CII, and OII were developed by personnel in the Injury Prevention program at the USACHPPM. The MIII captures a greater number of injuries than the III, including more overuse-type injuries. The CII captures all ICD-9 codes related to injuries. The OII captures musculoskeletal injuries resulting from cumulative microtrauma (overuse-type injuries). The OII includes such diagnoses as stress fractures, stress reactions, tendonitis, bursitis, fasciitis, arthralgia, neuropathy, radiculopathy, shin splints, synovitis, and strains.

h. Attrition

(1) Attrition was defined as not completing BCT in the originally assigned BCT company within the 9-week period. Reasons for attrition included discharge, recycling, or being absent without leave (AWOL, leaving BCT without specific authorization). Individual attrition was obtained from a local data system maintained at Fort Jackson and these were cross-checked with two Army-wide databases called the Resident Individual Training Management (RITM) system and the Automated Instructional Management System-Personal Computer (AIMS-PC). The date and reason the trainee left the unit were recorded.

(2) Discharges were subjects who were not suitable for service in the Army and were formally released from their Service commitment during the course of BCT. There were numerous reasons for which a subject could have been discharged but most fell into two major categories: medical conditions that existed prior to Service (EPTS discharge) or poor entry-level performance. The latter category is often called an entry-level separation (ELS) or Chapter 11 discharge. ELS discharges are most often the result of inability to adapt to the military environment because of lack of ability (cannot adequately perform critical military tasks) or for

psychosocial reasons (motivation, inability to follow orders, personality problems, etc.). The date of discharge and reason were recorded.

(3) Recycles were subjects leaving their original training company and entering another BCT company before the end of the 9-week BCT cycle. New Soldiers are generally recycled because they cannot complete mandatory requirements for reasons such as low motivation, serious injury, emergency leave, or inability to meet specific training standards with their peers (i.e., difficulty developing specific skills like basic rifle marksmanship, difficulty passing the APFT, etc.). The date the subject was recycled was recorded.

(4) A special category of recycles was individuals who were injured or became ill during BCT to the extent that they could not continue training. These individuals were sent to the Physical Training and Rehabilitation Program (PTRP) to recover from their injury or illness. After recovery, they returned to BCT. The PTRP unit maintained a separate list of these individuals and this list was obtained to cross-check the recycle information for Soldiers assigned to the PTRP. The date the subject was assigned to the PTRP and the nature of the injury or illness were obtained.

i. Statistical Analysis

(1) Statistical analysis was conducted using the SPSS statistical package, version 16.0 (SPSS Inc., Chicago, IL). Body mass index (BMI) was calculated as weight/height^2 (61). Comparisons were made between the entire ISG and PG on attrition, age, physical characteristics, physical fitness, demographic characteristics, questionnaire variables. Subgroup comparisons were made for the ID and IDA subjects. For discrete, nominal, and ordinal variables, comparisons were made using the chi-square statistic; for continuous measures, group comparisons were performed using independent sample t-tests.

(2) APFT scores were analyzed by independent sample t-test for group comparisons only; if examining multiple administrations of the APFT, a mixed-model analysis of variance with repeated measures (group × APFT administration) was used. Each of the three APFT test events was analyzed separately. Paired t-tests and Pearson product moment correlations were used to compare subjects taking both APFT1 and APFT2.

(3) For all injury indices, person-time injury incidence rates (injured subjects/1000 person-days) were calculated as

$$\text{Subjects with} \geq 1 \text{ injury/total time in BCT} \times 100$$

(4) The total time in BCT was 63 days for subjects who completed BCT and less for those who attrited from training or withdrew from the study. Injury rate comparisons between ISG and PG were made using a chi-square for person-time (62).

(5) Cox regression was used to examine the associations between covariates (including group membership) and time to first CII injury. For each analysis, once a subject had an injury, her contribution to time in BCT was terminated. Those who attrited from training or chose to withdraw from the study had their time terminated (censored) at the day they left the unit or

withdrew from the study. All covariates were entered into the regression model as categorical variables. Some interval and ordinal variables were combined to increase statistical power. Most continuous variables were converted to three equal-sized groups (tertiles), based on the distribution of the scores. Age was partitioned into three groups (17–19, 20–24, and ≥25 years). Univariate Cox regressions were initially performed examining the association of time to first injury among levels of the single covariate. After this, multivariate Cox regression models were developed to determine the effect of multiple covariates on injury risk. Covariates were included in the initial multivariate model if they achieved $p<0.10$ in the univariate analyses (63). A backward stepping procedure was used to retain significant covariates in the final model. Group membership (PG or ISG) was forced into all multivariate models.

(6) Because there may be a period of time before the effects of iron supplementation on injury are manifest, separate univariate Cox regressions were also performed to examine injury risk by groups in 2-week blocks of BCT. For this analysis each 2-week block was considered as a separate period. Once a subject had an injury, his or her contribution to the time within the block was terminated. Those who attrited from training or chose to withdraw from the study had their time terminated (censored) at the day they left the unit or withdrew from the study. Those who attrited from training or withdrew from the study in a particular block were not considered in subsequent 2-week blocks. If an injury occurred within the block, it was considered a new injury and the subject had her time terminated within that block.

6. RESULTS

a. A total of 219 women volunteered for the study. The DMSS found medical data on 208 of the women (95%) and only these were considered in the subsequent analyses. Of the 208 women, 103 were in the PG and 105 were in the ISG. Of the 208 women, 28 (13%) attrited from training for reasons outlined in Table 2. However, three discharges and nine recycles did not occur until the last day of training. Five of the recycles were sent to the PTRP, four for stress fractures (1.9% stress fracture incidence) and one for an "ankle trauma." Two soldiers left BCT early because they had completed all the critical tasks and were needed elsewhere; since they were not present the entire BCT cycle, they were considered attrites for the purposes of the study.

b. A total of 45 women withdrew from the study for various reasons outlined in Table 2. Three subjects withdrew and then later attrited from training (one recycle and two discharges).

Table 2. Reasons for Attrition and Withdrawals

Attrition		
Reason	**n**	**Proportion (%)[a]**
Discharge	10	4.8
Recycles	15	7.2
Early BCT Completion	2	1.0
AWOL	1	0.5

Withdrawals		
Reason	**n**	**Proportion (%)[a]**
Personal	16	7.7
Attrition (any reason)	13	6.3
Medical	3	1.4
Anemia	3	1.4
Prenatal Vitamins	1	0.5
Unknown	9	4.3

a. Proportion of 208 subjects

a. Comparison of PG and ISG

(1) Attrition and Withdrawal. Table 3 shows differences between the PG and ISG in withdrawals, total attrition and various types of attrition. There was very little group difference in the proportion of withdrawals, total attrition, or attrition due to discharge, recycle, PTRP, or AWOL.

Table 3. Comparison of Withdrawal and Attrition in PG and ISG

	PG		ISG		p-value[a]
	No (n)	Yes (n)	No (n)	Yes (n)	
Withdrawal	82	21	81	24	0.67
Total Attrition	92	11	90	15	0.22
Discharges	99	4	99	6	0.54
Recycles	97	6	96	9	0.44
PTRP	100	3	103	2	0.64
AWOL	102	1	105	0	0.31

a. Chi-square test

(2) Age and Physical Characteristics. Table 4 shows the group comparisons for age and the physical characteristics at the start of the investigation. Group differences were small for age, height, weight, BMI, body fat, and fat free mass.

Table 4. Group Comparisons for Age and Physical Characteristics

Variable	PG		ISG		p-value[a]
	n	Mean ± SD	n	Mean ± SD	
Age (yrs)	103	21.1 ± 4.8	105	20.7 ± 4.6	0.52
Height (cm)	103	162.5 ± 6.1	105	161.9 ± 6.2	0.38
Weight (cm)	103	138.4 ± 19.2	105	134.4 ± 19.6	0.47
BMI (lb)	103	23.8 ± 3.0	105	23.6 ± 3.1	0.61
Body Fat (%)	102	27.1 ± 5.8	105	25.9 ± 5.6	0.14
Fat Free Mass (lb)	102	100.2 ± 10.9	105	100.1 ± 11.3	0.97

a. Independent sample t-test

(3) Demographic Characteristics. Table 5 shows the group comparisons for the demographic variables. The distributions of subjects were similar within the two groups for component, educational level, race, and marital status.

Table 5. Comparisons of Demographic Characteristics in PG and ISG

Variable	Category of Variable	PG (n)	ISG (n)	p-value[a]
Component	Active Army National Guard Army Reserve	36 52 15	42 46 17	0.63
Educational Level	< High School Graduate High School Graduate Some College College Graduate Unknown	11 81 7 2 2	14 76 8 3 4	0.71

Table 5. (continued)

Variable	Category of Variable	PG (n)	ISG (n)	p-value[a]
Race	White Black Other	60 25 18	65 21 19	0.76
Marital Status	Married Single Other	83 15 5	85 18 2	0.44

a. Chi-square statistic

(4) APFT Events

(a) Of the six companies involved in the study, only three performed an initial APFT (APFT1, within 1 to 4 days of arrival in the BCT unit). One of these companies performed a 1-mile run rather than a 2-mile run. Other companies performed a second APFT (APFT2) about 2 weeks into the BCT cycle. It was possible that the second APFT could serve as an initial measure of fitness, if fitness did not change substantially from the first to the second test. Table 6 shows an analysis of subjects who completed both APFT1 and APFT2. As might be expected due to the 2 weeks of physical training (64) there were significant improvements in scores between the 2 weeks. Further, the correlations between the two tests indicate only 26% to 42% commonality (r^2*100%) suggesting differential improvements among subjects on the three test items. Thus, the second APFT could not be used as an initial measure of fitness and only subjects performing the initial APFT could be considered to have their fitness prospectively measured.

Table 6. Comparison of First and Second APFT

APFT Event	n	APFT1 (Mean ± SD)	APFT2 (Mean ± SD)	p-value[a]	Correlation[b]
Push-ups (reps)	61	10 ± 11	14 ± 15	0.04	0.60
Sit-ups (reps)	62	30 ± 15	41 ± 15	<0.01	0.65
2-Mile Run (min)	53	23.4 ± 1.6	20.9 ± 2.5	<0.01	0.51

a. From paired t-test
b. Pearson product moment correlation coefficient

(b) It would have been more appropriate to perform a two-way repeated measures ANOVA to analyze group differences across all four APFTs. However, statistical power would have been severely limited because very few subjects performed all four APFTs. A somewhat larger number of subjects had completed both APFT1 (initial test) and APFT4 (final test). Thus, a two-way mixed model ANOVA (group by test period) was performed with these subjects; Table 7 shows the results. In all cases, there were significant improvements by test period (APFT1 to APFT4). There were no significant group differences. The only significant interaction was for the sit-ups, where the PG improved more than the ISG.

Table 7. Comparison of First and Final APFT

APFT Event	APFT Number	PG		ISG		ANOVA p-values[a]		
		n	Mean ± SD	n	Mean ± SD	Group (PG, ISG)	Test Period (APFT1/APFT4)	Group × Test Period
Push-ups (reps)	APFT1	33	10 ± 12	37	11 ± 9	0.89	<0.01	0.52
	APFT 4		29 ± 14		28 ± 12			
Sit-ups (reps)	APFT 1	33	29 ± 15	37	34 ± 16	0.59	<0.01	0.07
	APFT 4		59 ± 13		58 ± 12			
2-Mile Run (min)	APFT 1	23	23.4 ± 1.8	29	23.4 ± 1.6	0.92	<0.01	0.80
	APFT 4		18.2 ± 1.8		18.0 ± 1.6			

a. Mixed model ANOVA with repeated measures

(c) To maximize sample size at each of the four APFTs, independent sample t-tests were performed comparing the mean values for each event at each administration of the APFT. Results are shown in Table 8. On APFT1 and APFT2, the PG and ISG differed little on any of the events. Push-ups and sit-ups also showed little group difference on APFT3 or APFT4. After virtually identical 2-mile run performances on APFT1 and APFT2, the ISG demonstrated slightly faster 2-mile run performance on APFT3 and APFT4. The ISG ran faster than the PG by an average of 1.1 minutes on APFT3 and 0.5 minutes on APFT4.

Table 8. Comparison of PG and ISG on Each APFT

APFT Number	APFT Event	PG		ISG		p-value[a]
		n	Mean ± SD	n	Mean ± SD	
APFT 1	Push Ups (reps)	43	9 ± 11	46	11 ± 10	0.40
	Sit-Ups (reps)	43	30 ± 15	46	32 ± 15	0.57
	2-Mile Run (min)	28	23.4 ± 1.8	36	23.5 ± 1.5	0.84
	1-Mile Run (min)	13	11.4 ± 1.6	7	10.5 ± 1.7	0.24
APFT 2	Push Ups (reps)	66	16 ± 14	64	17 ± 13	0.77
	Sit-Ups (reps)	65	42 ± 15	65	42 ± 16	0.90
	2-Mile Run (min)	60	21.7 ± 2.7	60	21.7 ± 2.6	0.98
APFT 3	Push Ups (reps)	52	20 ± 12	44	22 ± 12	0.50
	Sit-Ups (reps)	52	49 ± 16	44	50 ± 14	0.74
	2-Mile Run (min)	23	20.0 ± 2.0	26	18.9 ± 1.8	0.06
APFT4	Push Ups (reps)	76	27 ± 12	73	27 ± 12	0.70
	Sit-Ups (reps)	76	55 ± 12	73	58 ± 13	0.31
	2-Mile Run (min)	76	18.4 ± 1.9	73	17.9 ± 1.5	0.13

a. Independent sample t-test

(5) Questionnaire

(a) Tables 9 and 10 show a comparison of the groups on the questionnaire variables. Table 9 shows the questions and the response categories as they appeared on the questionnaire. Table 10 shows the results with some response categories combined to increase statistical power.

(b) The PG had more subjects performing higher frequencies of pre-BCT aerobic activity compared with the ISG (Question 24) and more subjects self-rating themselves as more physically active (Question 40). The groups differed little on the distribution of subjects with regard to the frequency of strength training (Question 25).

(c) There were only small group differences in the distribution of individuals on the two questions relating to tobacco use (Questions 37 and 38). The prevalence of self-reported cigarette smoking was 17% (17/102 with one missing response) in the PG and 23% (23/102 with three missing responses) in the ISG. There was only one smokeless tobacco user in each group, so the prevalence of smokeless tobacco use was about 1% in both groups.

(d) Compared with the ISG, the PG tended to have more menstrual irregularities, although these differences were small and not statistically significant. PG subjects included a) more women whose period varied by 5–7 days from month to month, b) more women who had missed periods for more than 3 months in the last 2 years, and c) more women with bleeding between periods.

Table 9. Group Comparisons on Questionnaire Variables

Question	Response Categories	PG (n)	ISG (n)	p-value[a]
24. Prior to arriving at BCT, how often did you perform at least 20 minutes of nonstop exercise (such as running, biking, stair climbing)?	Rarely or never	18	37	<0.01
	1 time/week	9	17	
	2 times/week	24	17	
	3 times/week	20	10	
	4 times/week	15	11	
	5 times/week	6	2	
	6 times/week	3	2	
	Daily, generally no rest days	3	9	
	Multiple sessions daily	4	0	
	Missing	1	0	
25. Prior to arriving at BCT, how often did you lift weights or participate in other forms of strength conditioning exercise?	Rarely or never	54	66	0.16
	1 time/week	13	8	
	2 times/week	15	10	
	3 times/week	12	6	
	4 times/week	1	7	
	5 times/week	3	3	
	6 times/week	0	2	
	Daily, generally no rest days	2	2	
	Multiple sessions daily	1	1	
	Missing	2	0	
39. How would you rate yourself as to the amount of physical activity you performed prior to entering the Army, compared to others of your age and sex?	Much less than average	8	10	0.18
	Somewhat less than average	27	14	
	About the same	30	36	
	Somewhat more active	27	26	
	Much more active	10	16	
	Missing	1	3	
40. Over the last 2 months, how often did you exercise or play sports for 15 minutes or more on average?	No exercise or sports in the last 2 months	6	14	0.15
	<1 time/week	14	16	
	1 time/week	10	18	
	2 times/week	18	20	
	3 times/week	17	11	
	4 times/week	14	8	
	5 times/week	12	8	
	6 times/week	5	1	
	7 times/week	6	6	
	Missing	1	3	

Table 9. (continued)

Question	Response Categories	PG (n)	ISG (n)	p-value[a]
37. Which statement best describes your smoking habits in the last year (prior to BCT)?	I have never been a smoker I smoked but quit I smoke 10 or fewer cigarettes per day I smoke 11 to 20 cigarettes per day I smoke more than 20 cigarettes per day Missing	59 26 7 7 3 1	54 25 11 8 4 3	0.86
38. Which statement best describes your use of smokeless tobacco (chewing, dipping or pinching) in the last year (prior to BCT)?	I have never used smokeless tobacco I used smokeless tobacco but quit I use smokeless tobacco 1 time per day or less I use smokeless tobacco 2–4 times per day I use smokeless tobacco 5–10 times per day I use smokeless tobacco more than 10 times per day Missing	97 3 1 0 0 0 2	99 1 0 1 0 0 4	0.39
10. Do you have regular menstrual cycles?	No Yes Missing	25 77 1	23 82 0	0.66
12. Does the time between periods vary by 5–7 days from month to month	No Yes Missing	58 44 1	69 33 3	0.11
18. Within the last TWO years, have you ever missed your period for 3 months or longer WITHOUT being pregnant?	No Yes Missing	75 25 3	87 17 1	0.13
19. Have you ever had bleeding between periods?	No Once Several times Frequently Missing	56 25 19 1 2	70 16 14 3 2	0.15

a. From chi-square statistic. Missing subjects were not included in the analysis

Table 10. Group Comparisons on Questionnaire Variables with Collapsed Response Categories

Question	Response Categories	PG (n)	ISG (n)	p-value[a]
24. Prior to arriving at BCT, how often did you perform at least 20 minutes of nonstop exercise (such as running, biking, stair climbing)?	≤ 1 time per week 2–4 times per week ≥ 5 times per week	27 59 16	54 38 13	<0.01
25. Prior to arriving at BCT, how often did you lift weights or participate in other forms of strength conditioning exercise?	≤ 1 time per week 2–4 times per week ≥ 5 times per week	67 28 6	74 23 8	0.59
39. How would you rate yourself as to the amount of physical activity you performed prior to entering the Army, compared to others of your age and sex?	Much to somewhat less than average About the same Much to somewhat more active	35 30 37	24 36 42	0.23
40. Over the last 2 months, how often did you exercise or play sports for 15 minutes or more on average?	≤ 1 time per week 2–4 times per week ≥ 5 times per week	30 49 23	48 39 15	0.03
37. Which statement best describes your smoking habits in the last year (prior to BCT)?	I have never been a smoker I smoked but quit Smoker	59 26 17	54 25 23	0.57

Table 10. (continued)

Question	Response Categories	PG (n)	ISG (n)	p-value[a]
38. Which statement best describes your use of smokeless tobacco (chewing, dipping or pinching) in the last year (prior to BCT)?	I have never used smokeless tobacco I used smokeless tobacco but quit User	97 3 1	99 1 1	0.60
10. Do you have regular menstrual cycles?	No Yes	25 77	23 82	0.66
12. Does the time between periods vary by 5–7 days from month to month?	No Yes	58 44	69 33	0.11
18. Within the last TWO years, have you ever missed your period for 3 months or longer WITHOUT being pregnant?	No Yes	75 25	87 17	0.13
19. Have you ever had bleeding between periods?	No Once Several Times/Frequently	56 25 20	70 16 17	0.15

a. From chi-square statistic. Missing responses are not shown and were not considered in the analysis

(6) Injury Analysis

(a) Table 11 shows the person-time injury incidence rates for the various injury indices and compares the rates in the PG and ISG. The group differences in rates were very small, although injury rates tended to be lower in the PG.

Table 11. Comparison of Person-Time Injury Incidence Rates of PG and ISG for the Injury Indices

Index	Injury Incidence Rates (injuries/1000 person-days)		Rate Ratio-ISG/PG (95% Confidence Interval)	p-value[a]
	PG	ISG		
Installation Injury Index	9.87	11.23	1.14 (0.79–1.63)	0.24
Modified Installation Index	10.59	11.58	1.09 (0.77–1.55)	0.31
Overuse Injury Index	8.26	9.62	1.16 (0.79–1.72)	0.22
Training-Related Injury Index	8.98	10.34	1.15 (0.79–1.68)	0.23
Comprehensive Injury Index	10.77	11.58	1.08 (0.76–1.52)	0.34

a. Chi-square for rates (62)

(b) Table 12 shows the results of the univariate Cox regression examining the association of time to first injury with group membership and the other factors. There was little difference in injury risk between the PG and the ISG. Injury risk tended to be higher among those who had less body fat, performed fewer push-ups, ran slower on the 2-mile run, were of "other" race, were married, rated themselves as less physically active, or reported frequent bleeding between periods.

Table 12. Injury Risk by Variable for All Subjects (Univariate Cox Regression)

Variable Grouping	Variable	Level of Variable	n	Hazard Ratio (95%CI)	p-value
Group	Group	PG	103	1.00	---
		ISG	105	1.10 (0.76–1.56)	0.59
Age	Age	17.0–19.9 years	123	1.00	---
		20.0–24.9 years	54	1.09 (0.72–1.67)	0.67
		≥25.0 years	31	1.33 (0.83–2.15)	0.24
Physical Characteristics	Height	57.0–63.0 inches	77	0.94 (0.61–1.44)	0.76
		63.1–65.0 inches	70	0.87 (0.55–1.37)	0.55
		65.1–71.3 inches	61	1.00	---
	Weight	95.7–128 pounds	69	1.00	---
		128.1–143.7 pounds	70	0.72 (0.46–1.12)	0.14
		143.8–194.7 pounds	69	1.05 (0.69–1.59)	0.82
	Body Mass Index	16.2–22.1 kg/m^2	69	1.00	---
		22.2–25.2 kg/m^2	70	0.81 (0.53–1.24)	0.33
		25.3–31.97 kg/m^2	69	0.77 (0.50–1.17)	0.22
	Body Fat	11.2–24.1%	69	1.00	---
		24.2–29.3%	69	0.69 (0.44–1.03)	0.07
		29.4–38.8%	70	0.69 (0.44–1.05)	0.08
	Fat-Free Mass	73.8–94.9 pounds	69	0.92 (0.60–1.41)	0.69
		95.0–104.3 pounds	69	0.95 (0.62–1.46)	0.81
		104.4–144.2 pounds	70	1.00	---
Physical Fitness	Push-Ups	0–2 repetitions	31	1.68 (0.91–3.13)	0.10
		3–11 repetitions	30	1.18 (0.63–2.19)	0.61
		121–48 repetitions	28	1.00	---
	Sit-Ups	0–25 repetitions	34	1.19 (0.65–2.20)	0.57
		26–38 repetitions	26	1.46 (0.78–2.73)	0.24
		39–61 repetitions	29	1.00	---
	2-Mile Run	17.9–23.7 minutes	21	1.00	---
		23.8–24.0 minutes	28	1.13 (0.57–2.26)	0.72
		24.1–26.0 minutes	15	2.12 (0.97–4.61)	0.06
Demographics	Component	Active Army	78	1.00	---
		National Guard	98	0.96 (0.65–1.40)	0.82
		Reserves	32	0.96 (0.56–1.63)	0.88
	Race	White	125	1.00	---
		Black	46	0.88 (0.57–1.37)	0.88
		Other	37	0.63 (0.38–1.03)	0.07
	Marital Status	Single	168	1.00	---
		Married	33	1.53 (0.97–2.39)	0.07
		Other	7	1.26 (0.51–3.10)	0.62
	Educational Level	High School Graduate	157	1.00	---
		Not High School Graduate	25	1.22 (0.73–2.05)	0.45
		Some College or College Graduate	0	0.92 (0.51–1.68)	0.79
		Unknown	6	1.78 (0.65–4.86)	0.26
Questions–Physical Activity	Question 24. Aerobic Training Frequency	≤ 1 times/week	81	0.91 (0.53–1.57)	0.74
		2–4 times/week	97	0.84 (0.50–1.43)	0.52
		≥5 times/week	29	1.00	---
	Question 25. Strength Training Frequency	≤ 1 times/week	141	1.19 (0.58–2.46)	0.63
		2–4 times/week	51	0.85 (0.39–1.87)	0.68
		≥5 times/week	14	1.00	---
	Question 39. Self-Rated Physical Activity	Much to Somewhat More Active	59	1.00	---
		Average	66	1.06 (0.66–1.71)	0.80
		Much to Somewhat Less Active	79	1.58 (1.02–2.43)	0.04

Table 12. (continued)

Variable Grouping	Variable	Level of Variable	n	Hazard Ratio (95%CI)	p-value
Questions–Physical Activity	Question 40. Sports/Exercise Frequency	8≤ 1 times/week	78	1.35 (0.81–2.24)	0.25
		2–4 times/week	88	1.17 (0.70–1.93)	0.56
		≥5 times/week	38	1.00	---
Questions–Tobacco Use	Question 37. Smoking Habits in Last Year	Never smoker	113	1.00	---
		Smoker	40	1.16 (0.75–1.83)	0.52
		Quit	51	1.30 (0.86–1.97)	0.21
	Question 38. Smokeless Tobacco Use	Never Used	196	1.00	---
		Used	2	0.63 (0.08–4.51)	0.65
		Quit	4	1.12 (0.36–3.52)	0.85
Questions–Menstrual Status	Question 10. Regular Menstrual Cycles	Yes	159	1.00	---
		No	48	1.11 (0.74–1.67)	0.62
	Question 12. Time Between Periods >5–7 days	Yes	77	0.76 (0.52–1.11)	0.16
		No	127	1.00	---
	Question 18. Missed Period >3 months	Yes	42	1.12 (0.72–1.74)	0.61
		No	162	1.00	---
	Question 19. Bleeding Between Periods	No	126	1.00	---
		Once	41	1.07 (0.68–1.69)	0.76
		Frequently	37	1.85 (1.18–2.90)	<0.01

(c) Table 13 shows the multivariate Cox regression (backward stepping procedure) examining the association of time to first injury with group membership and the other covariates. Push-ups and 2-mile run times were not included in the model because only 64 cases had complete data (31% of the total cohort). With the other variables meeting the inclusion criteria (i.e., p<0.10 in univariate analysis), there were 201 subjects with complete data to include in the multivariate model (97%). Table 13 shows that inclusion of the significant covariates still resulted in little difference in injury risk between the PG and the ISG.

Table 13. Injury Risk By Variable for All Subjects (Multivariate Cox Regression)

Variable	Level of Variable	n	Hazard Ratio (95%CI)	p-value
Group	PG	101	1.00	---
	ISG	100	1.14 (0.79–1.64)	0.48
Body Fat	11.2–24.1%	65	1.00	---
	24.2–29.3%	67	0.58 (0.37–0.91)	0.02
	29.4–38.8%	69	0.63 (0.41–0.97)	0.04
Question 39. Self-Rated Physical Activity	Much to Somewhat More Active	59	1.00	---
	Average	63	1.02 (0.63–1.66)	0.93
	Much to Somewhat Less Active	79	1.51 (0.97–2.34)	0.07
Question 19. Bleeding Between Periods	No	124	1.00	---
	Once	41	1.17 (0.73–1.85)	0.52
	Frequently	36	1.84 (1.15–2.98)	0.01

b. <u>Subgroup Comparisons of ID and IDA Subjects</u>. At the start of the investigation, there were 16 ID subjects in the PG and 18 ID subjects in the ISG. There were 22 IDA subjects in the PG and 21 IDA subjects in the ISG.

(1) Age and Physical Characteristics. Table 14 shows the group comparisons for age and physical characteristics for the ID and IDA subjects. Among the ID subjects, values were similar for the PG and ISG, although the PG tended to have more body weight. Among the IDA subjects, the ISG and PG values were very similar.

Table 14. Group Comparisons for Age and Physical Characteristics Among ID and IDA Subjects

Subgroup	Variable	PG		ISG		
		n	Mean ± SD	n	Mean ± SD	p-value[a]
ID	Age (yrs)	16	22.2 ± 6.3	18	20.7 ± 5.2	0.47
	Height (in)		64.3 ± 2.5		63.6 ± 2.0	0.41
	Weight (lb)		139.5 ± 17.6		129.8 ± 16.2	0.10
	BMI (kg/m^2)		23.8 ± 2.9		22.6 ± 3.0	0.25
	Body Fat (%)		27.2 ± 4.9		25.1 ± 4.5	0.21
	Fat Free Mass (lb)		101.3 ± 11.6		96.8 ± 10.0	0.24
IDA	Age (yrs)	22	21.9 ± 6.2	21	19.6 ± 3.2	0.14
	Height (in)		64.2 ± 2.4		64.1 ± 2.2	0.23
	Weight (lb)		140.6 ± 12.2		135.4 ± 16.0	0.88
	BMI (kg/m^2)		24.1 ± 2.2		23.3 ± 2.8	0.29
	Body Fat (%)		26.6 ± 4.9		25.2 ± 6.0	0.42
	Fat Free Mass (lb)		103.1 ± 9.3		100.7 ± 9.2	0.40

a. Independent sample t-test

(2) APFT Events

(a) It would have been most appropriate to perform a two-way repeated measures ANOVA to analyze group differences across the four APFTs. This was not possible because only three ID women and only two IDA women had complete data on all four tests. Thus, only the first and last tests were compared using a two-way mixed model ANOVA (group × test period).

(b) Table 15 shows the results for the ID and IDA subjects. Only subjects with results from both APFT1 and APFT4 were included in this analysis. On all three APFT events, ID subjects improved their raw scores from APFT 1 to APFT4. There were no significant group differences and no significant interactions on any test event.

(c) Table 15 shows that IDA subjects improved their performance from APFT1 to APFT4 on all three APFT events. There were no significant group differences on the push-ups or sit-ups. On the run, the ISG ran 1.07 times faster on APFT 1 than the PG (1.5 minutes faster); the ISG ran 1.10 times faster on APFT4 than the PG (1.8 minutes faster). There were no significant interactions for the push-ups or the run. On the sit-ups, the PG improved more than the ISG, but they also began at a lower performance level on APFT1. Analysis of covariance was used to adjust for the difference in the initial 2-mile run time in the IDA group. The group differences in the final run time were not statistically significant after this adjustment (p=0.19, PG n=5, ISG n=9).

Table 15. Group Comparison of APFT Raw Scores on APFT1 and APFT4 (ID and IDA Subjects)

Subgroup	APFT Event	APFT Number	PG n	PG Mean ± SD	ISG n	ISG Mean ± SD	ANOVA p-values[a] Group (PG, ISG)	Test Period (APFT1/APFT4)	Group × Test Period
ID	Push-ups (reps)	APFT1	4	8 ± 7	5	15 ± 9	0.77	<0.01	0.26
		APFT 4		36 ± 20		33 ± 8			
	Sit-ups (reps)	APFT 1	4	43 ± 13	5	36 ± 14	0.39	<0.01	0.75
		APFT 4		67 ± 22		57 ± 8			
	2-Mile Run (min)	APFT 1	3	22.5 ± 0.9	4	23.2 ± 1.0	0.33	<0.01	0.97
		APFT 4		16.6 ± 1.6		17.3 ± 0.2			
IDA	Push-ups (reps)	APFT1	10	8 ± 10	13	8 ± 8	0.50	<0.01	0.49
		APFT 4		23 ± 8		27 ± 15			
	Sit-ups (reps)	APFT 1	10	22± 12	13	36 ± 15	0.19	<0.01	0.04
		APFT 4		56 ± 16		56 ± 14			
	2-Mile Run (min)	APFT 1	5	24.4 ± 0.8	9	22.9 ± 1.6	0.06	<0.01	0.79
		APFT 4		19.7 ± 2.0		17.9 ± 2.0			

a. Mixed model ANOVA with repeated measures

(d) To maximize sample size on each of the four APFTs, independent sample t-tests were performed comparing the PG and ISG within each APFT event. Thus, PG and ISG groups were compared on each APFT for as many ID or IDA subjects as had taken that test. Table 16 shows the results. Among the ID subjects, the ISG performed more push-ups on APFT1 but group differences were very small at APFT4. There were small (and not statistically significant) group differences in sit-up performance on APFT1, but little difference at APFT4. Two-mile run times were identical on APFT1; on APFT2 and APFT3 the ISG ran about 10% faster than the PG (1.8 and 1.9 minutes faster); on APFT4, the ISG ran 5% faster than the PG (0.8 min faster).

Table 16. Comparison of PG and ISG on Each APFT (ID and IDA Subjects)

Subgroup	APFT Number	APFT Event	PG n	PG Mean ± SD	ISG n	ISG Mean ± SD	p-value[a]
ID	APFT 1	Push Ups (reps)	6	6 ± 6	5	15 ± 9	0.09
		Sit-Ups (reps)	6	44 ± 11	5	36 ± 14	0.32
		2-Mile Run (min)	4	23.2 ± 1.4	4	23.2 ± 1.0	0.94
		1-Mile Run (min)	2	10.9 ± 0.3	1	10.2 ± ---	---
	APFT 2	Push Ups (reps)	7	14 ± 14	9	20 ± 8	0.31
		Sit-Ups (reps)	7	39 ± 14	9	44 ± 16	0.48
		2-Mile Run (min)	5	22.5 ± 3.1	8	20.7 ± 2.7	0.30
	APFT 3	Push Ups (reps)	8	15 ± 14	7	24 ± 10	0.17
		Sit-Ups (reps)	8	52 ± 10	7	53 ± 16	0.88
		2-Mile Run (min)	4	20.4 ± 1.3	4	18.5 ± 0.9	0.06
	APFT4	Push Ups (reps)	12	28 ± 14	13	29 ± 11	0.90
		Sit-Ups (reps)	12	55 ± 17	13	57 ± 14	0.83
		2-Mile Run (min)	12	18.4 ± 1.7	13	17.6 ± 1.2	0.19

Table 16. (continued)

Subgroup	APFT Number	APFT Event	PG	ISG	p-value[a]	Subgroup	APFT Number
IDA	APFT 1	Push Ups (reps)	12	7 ± 9	14	8 ± 7	0.69
		Sit-Ups (reps)	12	21 ± 11	14	36 ± 15	<0.01
		2-Mile Run (min)	6	24.6 ± 0.9	10	23.0 ± 1.5	0.04
		1-Mile Run (min)	6	11.7 ± 2.0	2	10.9 ± 1.9	0.65
	APFT 2	Push Ups (reps)	10	7 ± 8	11	10 ± 13	0.51
		Sit-Ups (reps)	10	34 ± 17	11	40 ± 10	0.38
		2-Mile Run (min)	8	22.7 ± 2.2	9	22.0 ± 2.9	0.58
	APFT 3	Push Ups (reps)	8	17 ± 10	9	16 ± 11	0.92
		Sit-Ups (reps)	8	48 ± 15	9	48 ± 16	0.98
		2-Mile Run (min)	6	20.5 ± 1.7	8	19.5 ± 1.6	0.29
	APFT4	Push Ups (reps)	17	24 ± 10	15	25 ± 16	0.67
		Sit-Ups (reps)	17	55 ± 15	15	56 ± 14	0.86
		2-Mile Run (min)	17	19.9 ± 1.6	15	18.0 ± 2.0	<0.01

a. Independent sample t-test

(e) For the IDA subjects, push-up scores were similar for the PG and ISG throughout the four APFT administrations. The ISG had higher initial sit-up scores (APFT1), but scores at APFT3 and APFT 4 were almost identical. On the 2-mile run, the ISG was running 11% faster than the PG on APFT 1 (1.6 minutes faster) and APFT4 (1.9 minutes faster).

(3) Injury Data for ID and IDA Subjects

(a) Table 17 compares injury rates in the PG and ISG for the ID and IDA subjects. There was little difference in injury rates between the PG and ISG regardless of the injury index examined.

Table 17. Comparison of Person-Time Injury Incidence Rates Between PG and ISG for the Injury Indices (ID and IDA Subjects)

Subgroup	Index	Injury Incidence Rates (injuries/1000 person-days)		Rate Ratio-ISG/PG (95% Confidence Interval)	p-value[a]
		PG	ISG		
ID	Installation Injury Index	10.07	11.68	1.16 (0.48–2.78)	0.37
	Modified Installation Index	12.30	11.68	0.95 (0.41–2.18)	0.45
	Overuse Injury Index	7.83	7.43	0.95 (0.33–2.70)	0.46
	Training-Related Injury Index	8.94	8.59	0.95 (0.36–2.52)	0.46
	Comprehensive Injury Index	13.42	11.68	0.87 (0.39–1.97)	0.37
IDA	Installation Injury Index	11.25	10.40	0.93 (0.42–2.02)	0.42
	Modified Installation Index	11.25	10.40	0.93 (0.42–2.02)	0.42
	Overuse Injury Index	9.52	9.53	1.00 (0.44–2.30)	0.50
	Training-Related Injury Index	10.38	9.53	0.92 (0.41–2.07)	0.42
	Comprehensive Injury Index	11.25	10.40	0.93 (0.42–2.02)	0.42

a. Chi-square for rates (62)

(b) Because of the small sample size for ID subjects (n=34) only a univariate Cox regression analysis was run comparing injury risk by group membership. Results are shown in Table 18. There was little difference in injury risk between the PG and ISG.

Table 18. Injury Risk by Group for ID Subjects (Univariate Cox Regression)

Group	n	Hazard Ratio (95%Confidence Interval)	p-value
PG	16	1.00	---
ISG	18	0.85 (0.41–2.10)	0.85

(c) Table 19 shows the univariate Cox regression examining the association of time to first injury with group membership and the other covariates for the IDA subjects. There was little difference in injury risk between the PG and the ISG. Injury risk tended to be higher among IDA subjects who were older, performed fewer push-ups, had some college or were college graduates, performed more aerobic training prior to BCT, or had quit smoking.

Table 19. Injury Risk by Variable for IDA Subjects (Univariate Cox Regression)

Variable Grouping	Variable	Level of Variable	n	Hazard Ratio (95%CI)	p-value
Group	Group	PG	22	1.00	---
		ISG	21	0.88 (0.40–1.94)	0.76
Age	Age	17.0–19.9 years	30	1.00	---
		20.0–24.9 years	7	1.88 (0.67–5.26)	0.23
		≥25.0 years	6	3.16 (1.13–8.84)	0.03
Physical Characteristics	Height	59.8–63.3 inches	13	1.16 (0.43–3.13)	0.77
		63.4–65.0 inches	17	1.37 (0.51–3.69)	0.53
		65.1–70.0 inches	13	1.00	---
	Weight	108.5–132.3 pounds	14	1.00	---
		1324.–147.2 pounds	15	1.44 (0.54–3.86)	0.47
		147.3–168.1 pounds	14	1.50 (0.55–4.05)	0.43
	Body Mass Index	17.86–22.61 kg/m^2	14	1.00	---
		22.62–24.88 kg/m^2	15	1.12 (0.42–3.00)	0.83
		24.89–28.55 kg/m^2	14	1.34 (0.50–3.61)	0.56
	Body Fat	13.4–23.9%	14	1.00	---
		24.0–29.2%	15	0.68 (0.26–1.77)	0.43
		29.3–34.1%	14	0.61 (0.23–1.64)	0.33
	Fat-Free Mass	73.8–100.2 pounds	14	0.40 (0.13–1.23)	0.11
		100.4–104.6 pounds	15	1.52 (0.62–3.73)	0.36
		104.7–144.2 pounds	14	1.00	---
Physical Fitness	Push-Ups	0 repetitions	9	3.05 (0.95–9.80)	0.06
		1–11 repetitions	8	1.06 (0.31–3.68)	0.93
		12–25 repetitions	9	1.00	---
	Sit-Ups	0–20 repetitions	9	2.11 (0.60–7.58)	0.25
		21–38 repetitions	9	2.29 (0.67–7.85)	0.19
		39–61 repetitions	8	1.00	---
	2-Mile Run	20.5–23.6 minutes	4	1.00	---
		23.7–24.5 minutes	9	1.90 (0.38–9.48)	0.43
		24.6–26.0 minutes	7	2.50 (0.48–13.03)	0.28
Demographics	Component	Active Army	19	1.00	---
		National Guard	17	1.41 (0.58–3.40)	0.45
		Reserves	7	2.25 (0.75–6.77)	0.15

Table 19. (continued)

Variable Grouping	Variable	Level of Variable	n	Hazard Ratio (95%CI)	p-value
Demographics	Race	White	20	1.00	---
		Black	18	0.52 (0.21–1.25)	0.14
		Other	5	0.89 (0.29–2.73)	0.83
	Marital Status	Single	37	1.00	---
		Married	4	2.20 (0.65–7.44)	0.21
		Other	2	0.71 (0.10–5.25)	0.73
	Educational Level	High School Graduate	34	1.00	---
		Not High School Graduate	4	1.42 (0.42–4.83)	0.58
		Some College or College Graduate	4	2.92 (0.83–10.30)	0.10
		Unknown	1	a	a
Questions	Question 24. Aerobic Training Frequency	≤ 1 times/week	18	0.28 (0.07–1.12)	0.07
		2–4 times/week	20	0.15 (0.04–0.62)	<0.01
		≥5 times/week	5	1.00	---
	Question 25. Strength Training Frequency	≤ 1 times/week	29	1.09 (0.25–4.70)	0.91
		2–4 times/week	10	0.54 (0.10–2.94)	0.48
		≥5 times/week	4	1.00	---
	Question 39. Self-Rated Physical Activity	Much To Somewhat More Active	11	1.00	---
		Average	14	0.71 (0.24–2.04)	0.52
		Much to Somewhat Less Active	18	0.96 (0.38–2.40)	0.93
	Question 40. Sports/ Exercise Frequency	≤ 1 times/week	16	0.85 (0.32–2.29)	0.72
		2–4 times/week	15	1.24 (0.46–3.35)	0.67
		≥5 times/week	12	1.00	---
	Question 37. Smoking Habits in Last Year	Never smoker	25	1.00	---
		Smoker	9	1.96 (0.76–5.10)	0.17
		Quit	9	3.21 (1.23–8.40)	0.02
	Question 38. Smokeless Tobacco Use	Never Used	43	b	b
		Used	0		
		Quit	0		
	Question 10. Regular Menstrual Cycles	Yes	33	1.00	---
		No	10	0.78 (0.29–2.09)	80.63
	Question 12. Time Between Periods >5–7 days	Yes	20	1.03 (0.47–2.31)	0.93
		No	30	1.00	---
	Question 18. Missed Period >3 months	Yes	7	2.25 (0.53–9.55)	0.27
		No	36	1.00	---
	Question 19. Bleeding Between Periods	No	30	1.00	---
		Once	5	1.45 (0.42–5.00)	0.56
		Frequently	8	1.34 (0.49–3.65)	0.57

a. Not considered in the analysis
b. No analysis performed because of lack of variability

(d) Push-ups were not included in the multivariate Cox regression model because only 26 of the 43 subjects (60%) had push-up data. For the other variables which met the multivariate analysis entry criteria (p<0.10 in the univariate analysis), all 43 subjects had complete data. Table 20 shows the results of the backward stepping multivariate Cox regression. Inclusion of significant variables from the univariate analysis had little influence on the injury risk in the PG and ISG.

Table 20. Injury Risk By Variable for IDA Subjects (Multivariate Cox Regression)

Variable	Level of Variable	n	Hazard Ratio (95%CI)	p-value
Group	PG	22	1.00	---
	ISG	21	0.87 (0.36–2.07)	0.75
Question 24. Aerobic Training Frequency	≤ 1 times/week	18	0.27 (0.06–1.14)	0.07
	2–4 times/week	20	0.11 (0.03–0.52)	<0.01
	≥5 times/week	5	1.00	---
Age	17.0–19.9 years	30	1.00	---
	20.0–24.9 years	7	1.80 (0.60–5.37)	0.29
	≥25.0 years	6	4.34 (1.49–12.62)	<0.01

c. Injury Analysis by 2-Week Blocks. Table 21 shows the univariate Cox regression analyses analyzing group differences in time to first injury in 2-week blocks. In all cases, there was little group difference in injury risk. Also, there appears to be no pattern suggesting a decrease in injury risk in the ISG over the weeks.

Table 21. Injury Risk by Group in 2-Week BCT Blocks (Univariate Cox Regression)

		Entire Group			ID			IDA		
Block	Group	n	Hazard Ratio (95%CI)	p-value	n	Hazard Ratio (95%CI)	p-value	n	Hazard Ratio (95%CI)	p-value
Weeks 1–2	PG	103	1.00	---	16	1.00	---	22	1.00	---
	ISG	105	1.02 (0.62–1.67)	0.95	18	2.40 (0.47–12.40)	0.30	21	0.74 (0.27–1.98)	0.54
Weeks 3–4	PG	92	1.00	---	14	1.00	---	19	1.00	---
	ISG	94	0.96 (0.60–1.53)	0.86	15	0.54 (0.13–2.28)	0.41	19	1.38 (0.55–3.43)	0.49
Weeks 5–6	PG	88	1.00	---	14	1.00	---	18	1.00	---
	ISG	89	1.10 (0.66–1.81)	0.72	15	0.69 (0.16–3.10)	0.63	18	0.83 (0.25–2.73)	0.70
Weeks 7–8	PG	86	1.00	--	14	1.00	---	18	1.00	---
	ISG	84	0.97 (0.59–1.58)	0.88	14	0.78 (0.24–2.55)	0.68	18	1.11 (0.39–3.16)	0.85
Week 9	PG	83	1.00	---	14	1.00	---	17	1.00	---
	ISG	82	1.25 (0.34–4.66)	0.74	14	0.95 (0.13–6.71)	0.95	18	0.48 (0.04–5.30)	0.54

7. DISCUSSION

a. In the present study, it was hypothesized that iron supplementation might increase aerobic endurance during training (4) and this could possibly mediate a reduction in injuries, since increasing aerobic endurance has been shown to reduce injury incidence (8). However, this study found that providing iron supplements to female basic trainees had little influence on injury rates during BCT. Even when subjects who were ID or IDA at the start of the investigation were examined separately, injury rates during BCT were similar regardless of whether or not the subjects received the iron supplement. When factors associated with injury in the present study were included in multivariate models, iron supplementation still demonstrated little influence on injury risk. Finally, there was no pattern indicating that iron supplementation decreased injury risk later in training, as might have been the case if iron supplementation required a period of time to become effective.

b. There were suggestions from the data that iron supplementation improved aerobic endurance to a greater extent than the placebo. This could not be demonstrated statistically because of the small number of subjects for whom 2-mile run times were obtained, but some

trends could be noted. Figures 1, 2, and 3 compare 2-mile run times for the ISG and PG in the 1) entire sample, 2) in the ID subjects, and 3) in the IDA subjects, respectively. These are the 2-mile run times from Tables 8 and 16, which considered as many subjects as possible at each APFT administration. In Figure 1, showing the entire sample, the ISG and PG had almost identical run times on APFT1 and APFT2, but the ISG had faster average run times on APFT3 (6% or 1.1 minutes) and APFT 4 (3% or 0.5 minutes).

c. In Figure 2 showing the ID subjects, APFT1 times were identical for the PG and ISG, but the ISG had faster average times on APFT2 (9% or 1.8 minutes), APFT3 (10% or 1.9 minutes) and APFT4 (5% or 0.8 minutes). Figure 2 data are in general agreement with Hinton and Sinclair (4), who found a 10% improvement on a 15-km cycle time trial (complete the distance as quickly as possible) after 6 weeks of iron administration and 4 weeks of cycle ergometer training.

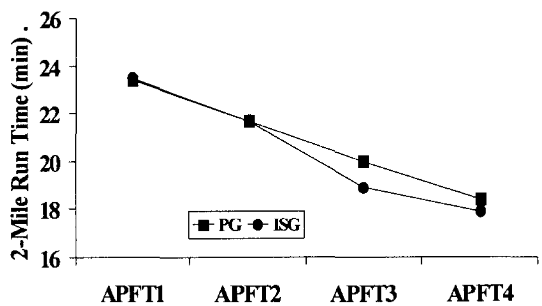

Figure 1. Changes in APFT 2-Mile Run Scores in PG and ISG (Entire Group)

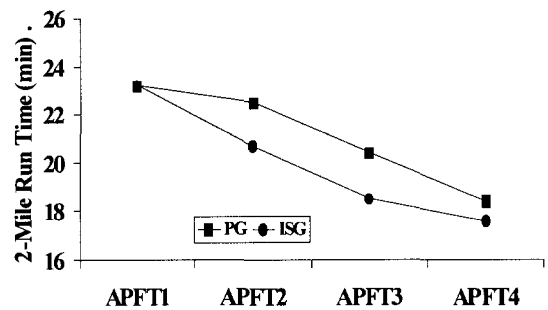

Figure 2. Changes in APFT 2-Mile Run Scores in PG and ISG with ID

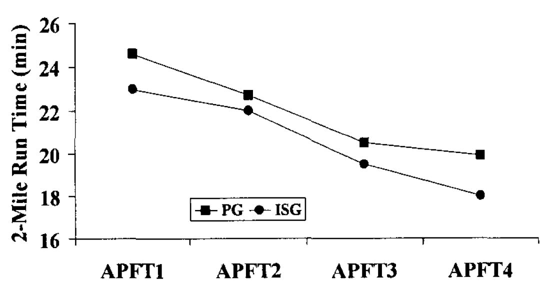

Figure 3. Changes in APFT 2-Mile Run Scores in PG and ISG with IDA

d. In Figure 3 showing the IDA subjects, results were somewhat confounded because of the greater initial performance of the ISG. On the final APFT4, the ISG was running 11%, or an average 1.9 minutes, faster than the PG. When the same subjects were compared on APFT1 and APFT4 (Table 15), results were similar to the comparison of all available subjects at each test administration (Figure 3): on APFT1, the ISG ran an average 7% faster (1.5 minutes faster) and on APFT4, the ISG ran an average 10% faster (1.8 minutes faster). Previous studies have shown

that those with slower initial 2-mile run times in BCT can improve those times to a greater extent than those with faster initial times (64), presumably because those with faster times are closer to their maximal training potential (47, 65). In this case, the ISG began with a faster time than the PG and maintained and improved their performance relative to the PG by the end of training (Figure 3).

e. Thus, there is some weak evidence that aerobic endurance did improve more with iron supplementation than with the placebo. In the survival analysis, there was a small trend for injury rates to be lower among subjects in the ISG group who were ID or had IDA. For the ID subjects, statistical power analysis indicated that with a sample size of about 1,130 in each group, the observed difference would be statistically significant (hazard ratio (ISG/PG)=0.85, hazard rate=0.1025/week, $p<0.05$, power=80%). For the IDA subjects, statistical power analysis indicated that with a sample size of about 1,680 in each group, the observed difference would be statistically significant (hazard ratio (ISG/PG)=0.88, hazard rate=0.0921/week, $p<0.05$, power=80%). The prevalences of ID and IDA were 16.3% and 20.7%, respectively in this sample. If the assumption is made that a battalion consists of 1000 BCT recruits and 40% of these recruits are women, then there are 400 women in a battalion. Of these 400, 66 would be ID and 83 would have IDA based on the prevalences in this study. Thus, assuming the required sample sizes in the power analyses, about 34 (ID) and 40 (IDA) battalions of recruits would be needed to achieve statistical significance under the above assumptions.

a. <u>Risk Factors</u>

(1) In general, the current study confirmed much of the previous work on injury risk factors in BCT. Higher injury risk was associated with slower run times and lower push-up performance, as has been found in much of the literature (7, 23, 54, 55, 66–70). There was also the suggestion of a systematic association, with progressively lower performance resulting in progressively higher injury risk as other studies have found (7, 25, 66). Individuals with lower levels of aerobic fitness and muscular endurance perform at a higher percentage of their maximal capacity during physical activities in BCT. They will likely fatigue more rapidly for both cardiovascular and metabolic reasons (71–73). Fatigue has been shown to result in changes in movement economy (74, 75) and gait (74–79) that may put more stress on body regions not accustom to the stress. Individuals with lower aerobic capacity may perceive long-term low intensity tasks as more difficult (80). The combined cardiovascular, metabolic, biomechanical, and perceptual stress could make injuries more likely in less fit individuals.

(2) Four items on the questionnaire dealt with physical activity prior to BCT. Higher levels of self-rated physical activity prior to BCT (Question 39) were associated with lower injury risk, in agreement with past BCT studies (7, 25, 52, 81–83). Physical activity of the proper intensity, frequency, and duration can increase aerobic fitness, muscle strength, and general health (84–88). Bone mineral density is higher in physically active individuals (89–92). These and other factors may assist in reducing susceptibility to injury (8).

(3) It was of interest that the data on aerobic training frequency (questionnaire item 24) for the IDA subjects did not correspond to previous studies showing that a higher frequency of pre-BCT aerobic training reduced injury risk (7, 25, 52, 81–83). In fact, just the opposite was true: IDA subjects with the highest aerobic training frequency were at the greatest injury risk.

There were only five IDA subjects in the highest training frequency (≥5 days/week). Further analysis of these five subjects showed that two withdrew from the study after 2 and 6 days and that the other three were all injured early in the 63-day BCT cycled, on days 6, 9, and 10. Thus, these five subjects may not have been typically representative of the larger population of recruits who trained aerobically prior to BCT. In fact, in the larger sample, there was little difference in injury risk by pre-BCT aerobic training frequency (Question 24). Alternately, it may be that IDA subjects with high aerobic training frequencies prior to BCT are more susceptible to injury in BCT, but with the small sample here this cannot be determined.

(4) It is not clear why higher levels of body fat were associated with lower injury risk. Most studies examining injury risk and body fat in BCT have shown no relationship (7, 54, 66), although one study did find higher body fat associated with higher injury incidence (55). Excessive fat would be expected to be detrimental because it serves as an additional burden on the body and is known to reduce performance (93–95). An increase in injury incidence might be expected in individuals with more body fat for this reason. However, there was little effect of body fat on initial APFT performance (APFT1) in the present study, as shown in Table 22. It is possible that individuals with a higher proportion of fat reduced their performance on other BCT activities (confidence/obstacle courses, rifle/bayonet training, convey operations, etc.) to avoid detrimental consequences.

Table 22. APFT1 Events by Body Fat Tertiles

Body Fat Tertile Ranges	Push-ups (reps)			Sit-ups (reps)			2-Mile Run (min)		
	n	Mean ± SD	p-value[a]	n	Mean ± SD	p-value[a]	n	Mean ± SD	p-value[a]
11.23–21.18%	33	13 ± 13	0.13	33	33 ± 15	0.50	26	23.2 ± 2.0	0.95
24.19–29.32%	27	8 ± 6		27	31 ± 15		23	23.2 ± 3.1	
29.33–38.81%	29	8 ± 6		29	29 ± 15		15	23.5 ± 1.1	

a. One-way analysis of variance

(5) Married individuals were also more likely to be injured in BCT, as other studies have found (23, 67). In the present study, marital status was not an independent risk factor when considered in the multivariate analysis. In past studies, when marital status was stratified on age there was little difference in injury incidence between married and single recruits (23, 67). Table 23 shows the results of a similar stratification. Stratification did not fully remove the association between marital status and injury, since the 20–24 year old married subjects still had a higher injury incidence than single subjects of the same age. It may be that marriage serves as an additional stressor in BCT. Problems in family life that cannot be immediately dealt with because the recruit is away from home may affect attention and increase fatigue and worry, and this could influence injury risk.

Table 23. Marital Status Stratified by Age[a]

Age Group	Single		Married		Risk Ratio – Married/Single (95%CI)	p-value
	n	Injury Incidence (%)	n	Injury Incidence (%)		
18–19 years	120	59.2	3	33.3	0.56 (0.11–2.81)	0.37
20–24 years	42	50.0	11	81.8	1.64 (1.08–2.47)	0.06
≥25 years	6	66.7	19	73.7	1.11 (0.59–2.07)	0.74

a. "Other" marital status (divorced and separated) was not included in the analysis because of the small sample size (n=7)

(6) Two other variables that have been shown to be associated with increased injury risk in BCT include older age (7, 25, 69, 81, 83) and cigarette smoking (7, 25, 69, 81, 96–99). These two variables did not reach statistical significance in the larger sample or the analysis of the IDA subjects, but the injury risks were in the expected directions in both cases.

b. Improvements in APFT Scores. In consonance with numerous other investigations, BCT was effective in increasing performance on the APFT scores (23, 64, 66, 67, 100, 101) regardless of initial iron status. The only significant group by APFT test interaction was for the sit-ups, where the PG improved more than the ISG. This was presumably because the initial performance of the PG was lower than that of the ISG. Interestingly, the final average performance level of the two groups was virtually identical. As noted above, it is more difficult for highly fit individuals to improve fitness during a training program compared with lower fit individuals, because they are closer to their maximum potential (47, 65). Thus the lower starting level of the PG may explain this finding.

8. CONCLUSION. The present study does not support the hypothesis that iron supplementation reduces injuries in BCT. The number of ID and IDA subjects was small, limiting statistical power. A larger study involving about 1700 ID and/or IDA subjects may be necessary to demonstrate the injury-reduction efficacy of iron supplementation.

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APPENDIX A
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APPENDIX B.
STUDY APPROVAL LETTER

DEPARTMENT OF THE ARMY
U.S. ARMY RESEARCH INSTITUTE OF ENVIRONMENTAL MEDICINE
KANSAS STREET
BUILDING 42
NATICK, MA 01760-5007

REPLY TO
ATTENTION OF

MCMR-EMZ-A (70-1n) 18 July 2007

MEMORANDUM THRU Chief, Military Nutrition Division

FOR Dr. James McClung, Principal Investigator

SUBJECT: Protocol Entitled, "Efficacy of iron supplementation for the maintenance of iron status during basic combat training," USARIEM H07-07

1. Subject research protocol was reviewed and determined to be no greater than minimal risk (NGTMR) to the volunteers.

2. Approval was recommended by the USARIEM Scientific Review Committee (SRC) on 12 June 2007, and by the USARIEM Human Use Review Committee (HURC) on 11 July 2007, upon modification(s).

3. All modifications have been accepted and regulatory compliance requirements have been met. Therefore, approval is granted for you to implement this study.

4. Please adhere to all directives. A Continuing Review Report must be submitted and reviewed by the HURC prior to the anniversary date of **10 July 2008.**

COL, SP

FOR BEAU J. FREUND
COL, MS
Commanding

CF:
MCMR-ZB-PH

APPENDIX C.
QUESTIONNAIRE

Efficacy of iron supplementation for the maintenance of iron status during basic combat training (H07-07)

Demographics and Background Survey

This questionnaire asks a variety of questions about your background and iron intake. Your answers will be kept confidential. This will take about 15 minutes of your time. Please make sure that you have answered all questions - on the front and back of all pages.

MARKING INSTRUCTIONS
Subject Number: ______

MARKING INSTRUCTIONS
• Use a No. 2 pencil only. • Do not use ink, ballpoint, or felt tip pens. • Make solid marks that fill the response completely. • Erase cleanly any marks you wish to change. • Make no stray marks on this form. CORRECT: ● INCORRECT:

DATE		
MONTH	DAY	YEAR
Jan		
Feb		
Mar		
Apr		
May		
June		
July		
Aug		
Sept		
Oct		
Nov		
Dec		

Below you will find an example of a question from this booklet. Please note the proper way to record your responses.

Example:

What is your age today?

If your answer is 19 years, then write 1 and 9 in the boxes and darken the corresponding circles. Please make sure that you use leading zeros when needed.

Please write in your response in the blank boxes, then fill in the corresponding circles.

years	1
	9

Dr. James McClung, PhD
Phone: 508-233-4979
E-mail questions to: James.McClung@na.amedd.army.mil
U.S. ARMY RESEARCH INSTITUTE OF ENVIRONMENTAL MEDICINE (USARIEM)

Demographics and Background Survey

1. **What is your age today?**

AGE years	

2. **Please indicate the HIGHEST level of education you have completed** (pick only one)
   - High school graduate (GED or diploma)
   - Some college courses
   - Associate degree (two-year college)
   - Bachelors degree (four-year college)
   - Graduate degree

3. **In what type of community did you live the longest before age 16?** (pick only one)
   - Central City of a Metropolitan Area
   - Suburbs of a Metropolitan Area (Non-rural and not in a Central City)
   - Nonmetropolitan (small town) Area
   - Rural Area (country)

4. **Where did you live the longest before the age of 16?** (pick only one)
   - New England (ME, NH, VT, MA, CT, RI)
   - Middle Atlantic (NJ, NY, PA)
   - South Atlantic (DE, MD, VA, WV, NC, SC, GA, FL, DC)
   - North Central (OH, IN, IL, MI, WI, MN, IA, MO, ND, SD, NE, KS)
   - South Central (KY, TN, AL, MS, AR, LA, OK, TX)
   - Mountain (ID, WY, CO, MT, AZ, NM, UT, NV)
   - Pacific (WA, OR, CA, AK, HI)
   - Foreign Country (please specify):____________
   - Other (please specify):____________________

5. **What is your ethnic background?**
   - Hispanic or Latino
   - Not Hispanic or Latino

6. **What is your racial background?**
   - White or Caucasian
   - Black or African American
   - Native American/Alaskan Native
   - Asian
   - Native Hawaiian/Pacific Islander
   - Other:____________________

7. **Are you trying to LOSE weight?**
   - Yes
   - No

8. **What was your weight change over the past year?** (fill in the ONE best response- gained, lost OR no change)

GAINED	LOST	NO CHANGE
1 - 5 pounds	1 - 5 pounds	
6 - 10 pounds	6 - 10 pounds	
11 - 15 pounds	11 - 15 pounds	
16 - 20 pounds	16 - 20 pounds	
21 + pounds	21 + pounds	

MENSTRUAL CYCLE: The following questions are going to ask you about your typical menstrual cycle (period). For clarification, when we ask about your "CYCLE" we are talking about the number of days from your first day of your period until the first day of your next period. This will include both bleeding and non-bleeding days. When we talk about your "PERIOD", we are only asking about the days you are bleeding. "FLOW" are the days you bleed.

9. How old were you when you had your first menstrual period?

9 years old
10 years old
11 years old
12 years old
13 years old
14 years old
Other age:______ (please specify)
Do not remember
Have not had a menstrual period (go to question #20)

10. Do you have regular menstrual cycles? (your period comes 25-31 days after the last one)

Yes (go to question #12)
No

11. If NO, approximately how many days elapse between periods?

Days	

12. Does the time between periods vary more than 5 - 7 days from month to month?

Yes
No

13. How many days, on average, does your period last?

None	Less than 1 day	More than 7 days

14. What was the date of your last period?

DATE		
MONTH	DAY	YEAR
Jan		
Feb		
Mar		
Apr		
May		
June		
July		
Aug		
Sept		
Oct		
Nov		
Dec		

Efficacy of iron supplementation for the maintenance of iron status during basic combat training (H07-07)

15. For how many days do you have your heaviest flow?

Days

16. Do you use tampons?

Yes
No (go to question 17)

16b. If YES to tampons, which type/capacity do you use?

Light
Regular
Super
Super Plus
Ultra

16c. What is the average number of tampons you use per day?

Number tampons

16d. How saturated do they become?

Light saturation
Medium saturation
Heavy saturation

17. Do you use pads?

Yes
No (go to question 18)

17b. If YES to pads, which type/capacity do you use?

Pantiliners
Ultra thin
Thin
Regular
Super
Overnight

17c. What is the average number of pads you use per day?

Number pads

17d. How saturated do they become?

Light saturation
Medium saturation
Heavy saturation

18. Within the last TWO years, have you ever missed your period for 3 months or longer WITHOUT being pregnant, ?

Yes
No

19. Have you ever had bleeding between periods?

No
Once
Several times
Frequently

Efficacy of iron supplementation for the maintenance of iron status during basic combat training (H07-07)

20. Have you ever been told by a health care provider that you were anemic or had low iron levels in your blood?

- Yes
- No (go to question 22)

21. If YES, did you take iron pills for your condition?

- Yes
- No

22. How many times did you donate a unit of blood last year? (pick only one)

- None
- 1 time
- 2 times
- 3 times
- 4 times
- 5 times
- 6 times
- Do not remember

23. When was the last time you donated blood?

DATE		
MONTH	DAY	YEAR
Jan		
Feb		
Mar		
Apr		
May		
June		
July		
Aug		
Sept		
Oct		
Nov		
Dec		

- Do not remember

24. Prior to arriving at BCT, how often did you perform at least 20 minutes of nonstop exercise (such as running, biking, stair climbing)?

- Rarely or never
- 1 time per week
- 2 times per week
- 3 times per week
- 4 times per week
- 5 times per week
- 6 times per week
- Daily, generally no rest days
- Multiple daily sessions

25. Prior to arriving at BCT, how often did you lift weights or participate in other forms of strength conditioning exercise?

- Rarely or never
- 1 time per week
- 2 times per week
- 3 times per week
- 4 times per week
- 5 times per week
- 6 times per week
- Daily, generally no rest days
- Multiple daily sessions

26. Prior to arrival at BCT, which meals did you eat on a regular basis (at least <u>5 times per week</u>). Please fill in one response for each line:

Yes	No	
		A. Breakfast
		B. Morning snack
		C. Lunch
		D. Afternoon snack
		E. Dinner
		F. Evening snack

27. Are you a vegetarian?

- No
- Yes, **Semi vegetarian** - occasionally eat poultry or fish, along with dairy and eggs.
- Yes, **Lacto-ovo vegetarian** - avoid all animal products except for dairy and eggs.
- Yes, **Lacto vegetarian** - avoid all animal produts except for dairy products
- Yes, **Vegan** - avoid all animal products including dairy and eggs

Demographics and Background Survey

28. Prior to arrival at BCT, where did *MOST* of your meals and snacks come from?
Select ONE choice for each meal and snack.

	BREAKFAST	MORNING SNACK	LUNCH	AFTERNOON SNACK	DINNER	EVENING SNACK
Home/Barracks (current residence)........						
Military dining facility..........................						
Fast food restaurants............................						
Restaurants (table service)....................						
Cafeterias (non military).......................						
All you can eat buffets..........................						
Vending machines................................						
Do not eat a meal/snack at this time.......						
Convenient stores						
Other ______________						

Q28J_oth

29. In the past 3 months, how many times per week did you consume the following foods (report the AVERAGE number of times per week, not the total for 3 months):

Milk (8 fl oz)
Cheese (1 oz/1 slice)
Yogurt (1 container)
Liver (3 oz)
Spinach (1/2 cup)
Red Meats (3 oz)
Eggs (1)
Cereal (1 cup)

30. Prior to arrival at BCT, how often did you drink coffee and/or tea during a meal or within one hour prior to or following a meal?

- 3 Meals per Day
- 2 Meals per Day
- 1 Meal per Day
- Occasionally
- Never

31. Prior to arrival at BCT, how often did you drink soft drinks/soda during a meal or within one hour prior to or following a meal?

- 3 Meals per Day
- 2 Meals per Day
- 1 Meal per Day
- Occasionally
- Never

32. Prior to arrival at BCT, how often did you drink orange juice during a meal or within one hour prior to or following a meal?

- 3 Meals per Day
- 2 Meals per Day
- 1 Meal per Day
- Occasionally
- Never

Efficacy of iron supplementation for the maintenance of iron status during basic combat training (H07-07)

33. Based on the past three months, use the table to estimate your use of each of the following vitamins and mineral supplements. Please fill in one circle for each item. DO NOT list the vitamins found in your Multi Vitamin under the individual vitamin/mineral section.

	Never	past 3 months but not now	Occasionally (<once per wk)	Frequently (1-6 times per wk)	Daily
Multiple Vitamin Supplements					
Individual Vitamins or Minerals					
Vitamin C					
Iron					
Calcium					
other ____________					

34. Are you using hormonal contraceptives (such as the "pill," patch, injection/shot, ring, implant)?
- Yes, I currently use hormonal contraceptives
- No, I never used hormonal contraceptives (go to question #36)
- No, used them in the past but not now (go to question #36)

35. How long have you been using hormonal contraceptives? If you have used them on more then 1 occurrence, add the time together for a total time
- Less then 6 months
- 6 months - 1 year (12 months)
- 13 months - 2 years (24 months)
- 25 months - 3 years (36 months)
- 3 or more years
- Do not remember

36. If NO to question #34, when did you stop using hormonal contraceptives?
- Less then 6 months ago
- 6 months - 1 year (12 months) ago
- 13 months - 2 years (24 months) ago
- 25 months - 3 years (36 months) ago
- 3 or more years ago
- Do not remember
- I have never used hormonal contraceptives

Efficacy of iron supplementation for the maintenance of iron status during basic combat training (H07-07)

37. Which statement best describes your smoking habits in the last year (prior to BCT)?

- I have never been a smoker
- I smoked but quit →
  - I quit less than 6 months ago
  - I quit 6 months to 1 year ago
  - I quit more than a year ago
- I smoke 10 or fewer cigarettes per day
- I smoke 11 to 20 cigarettes per day
- I smoke more than 20 cigarettes per day

38. Which statement best describes your use of smokeless tobacco (chewing, dipping, or pinching) in the last year (prior to BCT)?

- I have never used smokeless tobacco
- I used smokeless tobacco but quit →
  - I quit less than 6 months ago
  - I quit 6 months to 1 year ago
  - I quit more than a year ago
- I use smokeless tobacco 1 time per day or less
- I use smokeless tobacco 2 -4 times per day
- I use smokeless tobacco 5-10 times per day
- I use smokeless tobacco more than 10 times per day

39. How would you rate yourself as to the amount of physical activity you performed prior to entering the Army, compared to others of your age and sex?

- Much more active
- Somewhat more active
- About the same
- Somewhat less active
- Much less active

40. Over the last two months, how often did you exercise or play sports for 15 minutes or more on average?

- No exercise or sports in the last 2 months
- Less than once per week
- One time per week
- Two times per week
- Three times per week
- Four times per week
- Five times per week
- Six times per week
- Seven times per week